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JANUARY 1940

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WASHINGTON, D. C.

1940

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CORRECTIONS

August 1939, page 307, table 4, in the heading, change "April" to "August."

September 1939, page 352, table 4, bottom line, Ely, Nev., change "362.7" to "356.8."

October 1939, page 397, Oklahoma City, Okla., bottom line, change "363.4" to "358.6"; page 403, table 4, El Paso, Tex., bottom line, change "378.5" to "364.2."

MONTHLY WEATHER REVIEW

Editor, EDGAR W. WOOLARD

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A BRIEF LIST OF WORKS ON METEOROLOGY

Compiled by RICHMOND T. ZOCH

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RAINFALL MAPS OF CUBA

By THOMAS W. CHAMBERLIN

[State Teachers College, Johnson City, Tenn., May 1939]

A set of monthly rainfall maps [1] of the island of Cuba, based on the records [2] of 19 stations, was published in May 1928. Since that time additional data [3] have been recorded warranting a new set of maps, which, although similar in the major trends of the isohyets, show more local detail than has been possible previously. Of the 171 stations used in this study, 47 had from 4- to 6-year records, 79 from 7- to 11-year records, 27 from 12- to 20-year records, and 18 had from 21- to 67-year records. These included two stations on the Isle of Pines. The unreliability of short-term rainfall records is fully realized, but in all cases the longest record has been used in determining the final placement of the isohyets.

Cuba, about the size of Pennsylvania, has an area of 44,000 square miles. It is two and one half time as long as Pennsylvania and attains its maximum width of slightly over 80 miles in central Oriente Province. In contrast to most other islands of the West Indies, Cuba is essentially lowland, being distinctly mountainous or hilly in less than one-fourth its area. The construction of isohyets in these small, but relatively remote, areas must of necessity be theoretical, due to the paucity of stations in the sparsely inhabited uplands.

Cuba is under the influence of the trade winds throughout the year. In general, the wind prevails from the northeast from October to April and from the south and southeast during the summer months. The shift to the southeast in April is due to the general continental heating and lowering of pressure to the west and northwest of Cuba causing the trades to be drawn toward the North American continent in summer.

Pena Blanca, number 3 on the key map of Cuba, in Pinar del Rio Province, with a 5-year record, has the island's maximum annual rainfall of 79 inches. Union de Reyes, number 4 in Matanzas Province, with a 21-year record, ranks second with a 70-inch average.

The United States Naval Station at Guantanamo Bay, number 36 in Oriente Province, with a 10-year record, has the island's minimum annual average, slightly over 28 inches. The plains of the Guantanamo Bay area and the coast east of them are described by Bennett [4] and Leon [5] as the driest parts of the island.

The rainfall regime over most of Cuba has May–June and September–October double summer maxima. The only exception to this is the northeastern part of the island which experiences May–June and November maxima. Unlike the other portions of Cuba, this section receives its greatest rainfall in the months from October through February. The average annual rainfall of all stations on the island is 52.5 inches. In general the interior of the island receives more rainfall than the coastal areas.

From 50 to 75 percent of the area of Cuba receives less than 1 inch of rainfall in December and February; sections receiving more rain during these months are the mountains and north coast, since the trades are from the northeast at this time. In January there is a slight increase throughout the island. As the trades shift to the east and southeast in May, the south coast receives more rain. Thundershowers are most prevalent over the island from May to November, especially in the interior; during these months, the northeast coast receives less than the rest of the island.

The secondary rainfall minimum in July and August is associated with higher barometric pressure. In September and October the maximum is brought about by lower pressure, by occasional hurricanes, and, according to the late Dr. O. L. Fassig, by temporary "rapid increases in the depth of the trade winds which bring about a conflict with the so-called antitrades." [6] The increased rainfall due to orographic precipitation in the mountains and major hill areas shows up on most of the monthly maps.

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[1] Foscue, Edwin J. "Rainfall Maps of Cuba," MO. WEA. REV., 56:170–173, May 1928.

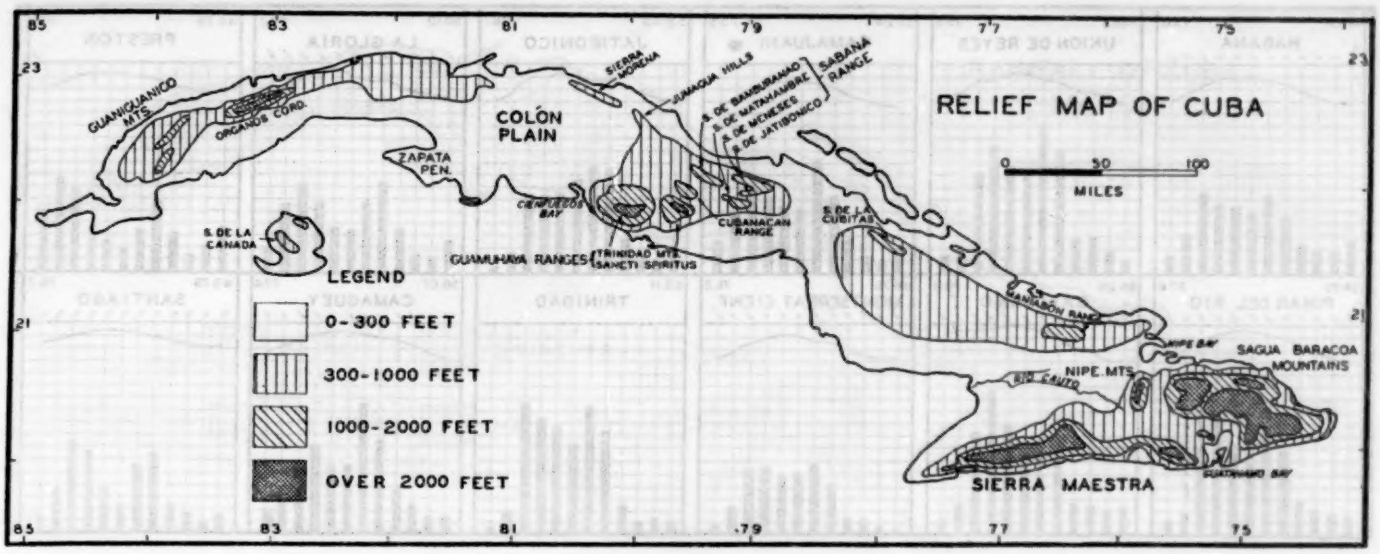
[2] Fassig, Oliver L., *Rainfall and Temperature of Cuba*, Washington D. C.: Tropical Plant Research Foundation, Bulletin No. 1, 1925.

[3] From 1927–33 the Cuba Sugar Club kept records of more than 1,000 rain gages scattered over the sugar-producing lands of Cuba. Mr. Charles Thrall, formerly a director of the now disbanded Sugar Club furnished the author with data published by the club during that period. These statistics, together with those published by W. W. Reed, Dr. O. L. Fassig, the United States Weather Bureau in its *Climatological Data, West Indies and Caribbean Service*, and data furnished by the United States Guantanamo Naval Station, form the bases for the construction of the maps accompanying this study.

[4] Bennett, Hugh H. and Robert V. Allison, *The Soils of Cuba*, Washington, D. C.: Tropical Plant Research Foundation, 1928.

[5] Shreve, Forest, editor, *Naturalists Guide to the Americas*. Section on Cuba by Brother Leon. Baltimore: Williams and Wilkins Co., 1926.

[6] Fassig, O. L., "The Trade Winds of the Eastern Caribbean" Transactions of the American Geophysical Union, Fourteenth Annual Meeting, 1933.


RELIEF MAP OF CUBA
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WEATHER STATIONS OF CUBA
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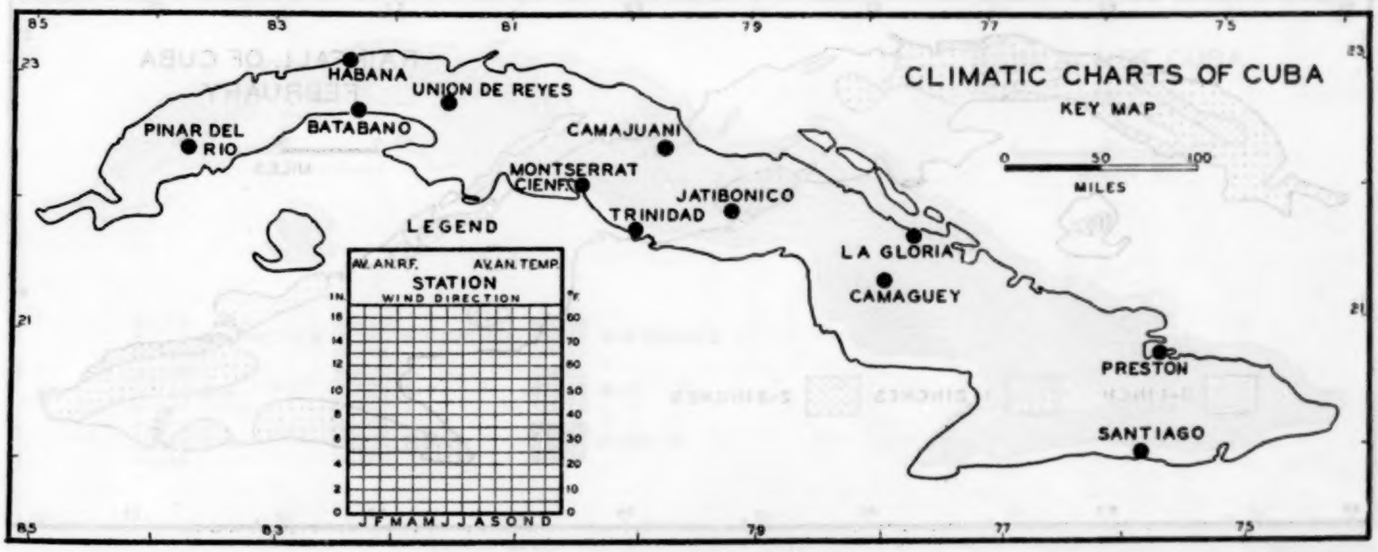
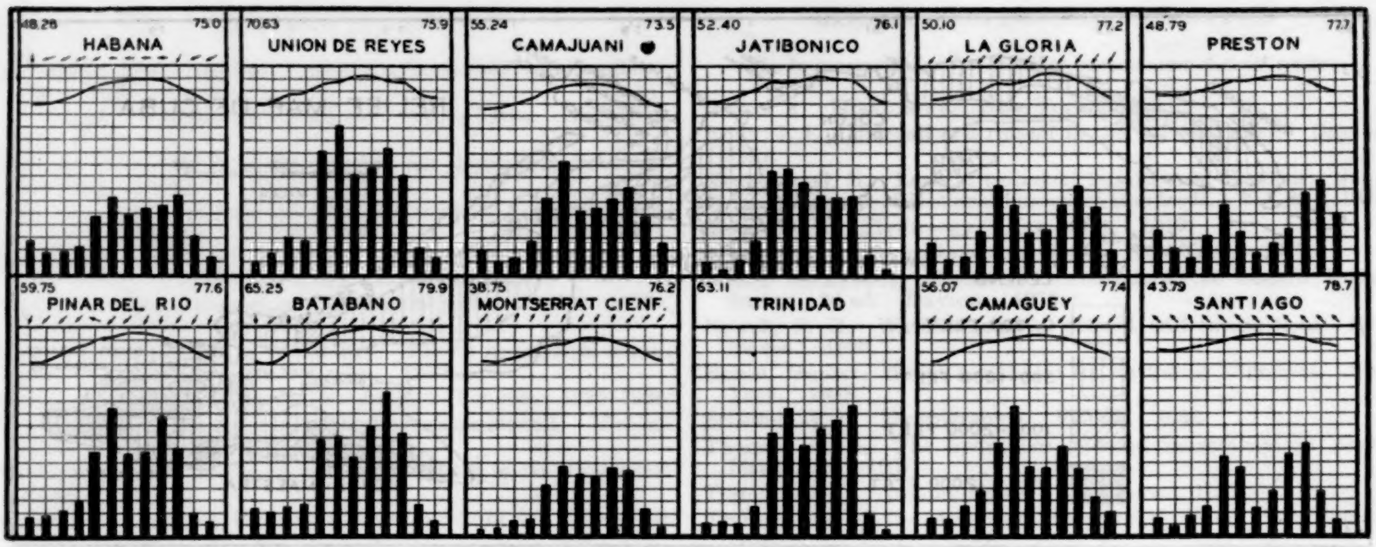

CLIMATIC CHARTS OF CUBA
KEY MAP
MILES
0 50 100
HABANA
UNION DE REYES
PINAR DEL RIO
BATABANO
CAMAJUANI
MONTSERRAT
CIENF.
JATIBONICO
TRINIDAD
LA GLORIA
CAMAGUEY
PRESTON
SANTIAGO
LEGEND
AV. AN. R.F.
AV. AN. TEMP.
STATION
WIND DIRECTION
J F M A M J J A S O N D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48.79 PRESTON 77.7
59.75 PINAR DEL RIO 77.6
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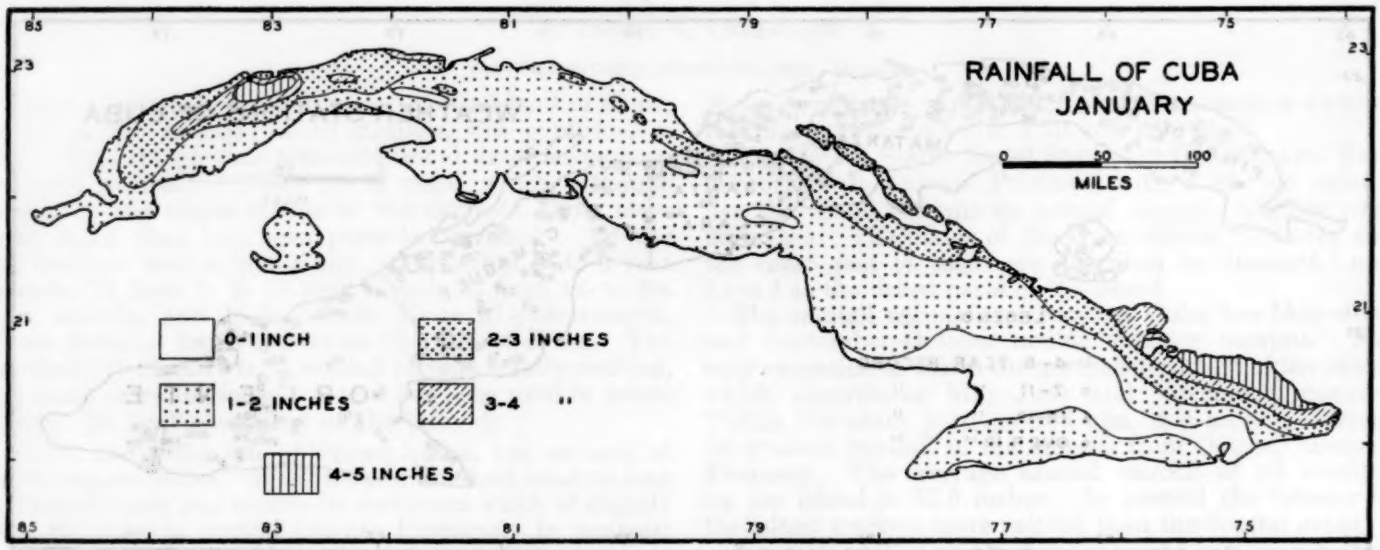
56.07 CAMAGUEY 77.4
43.79 SANTIAGO 78.7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MILES
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1-2 INCHES
2-3 INCHES
3-4 "
4-5 INCHES
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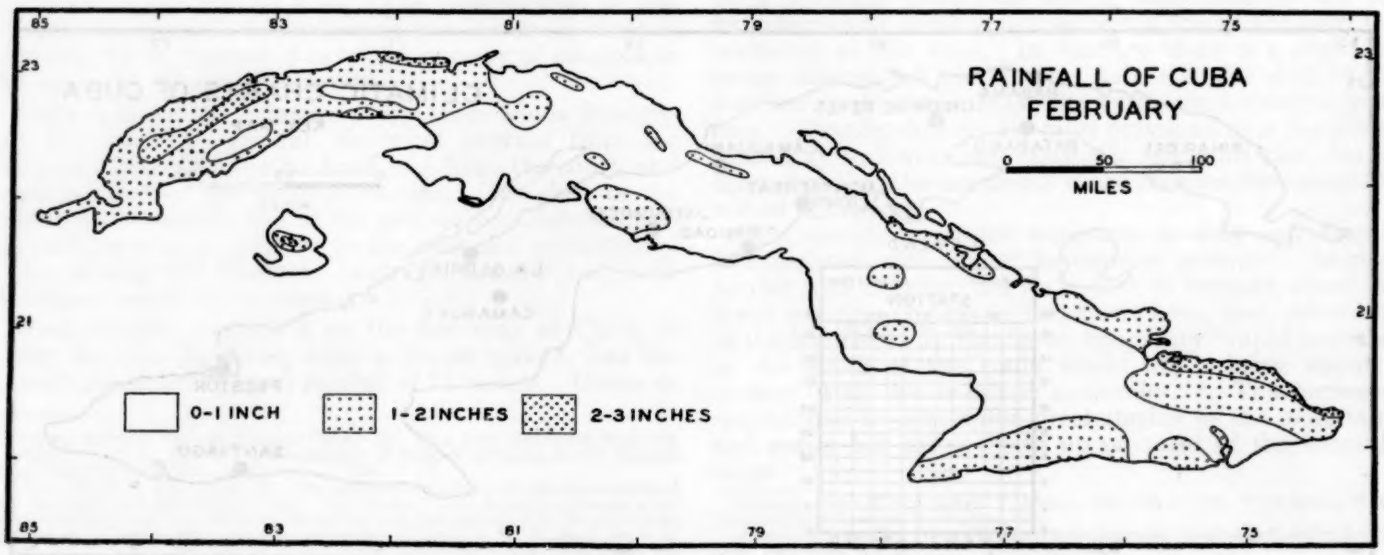
81
79
77
75
23
21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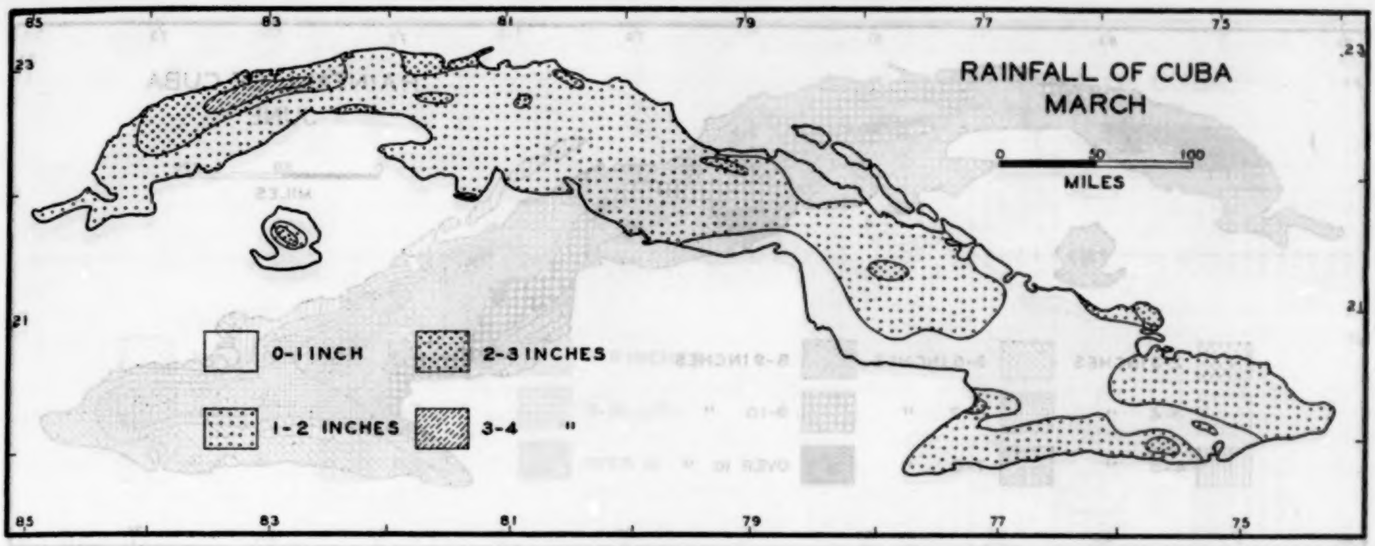
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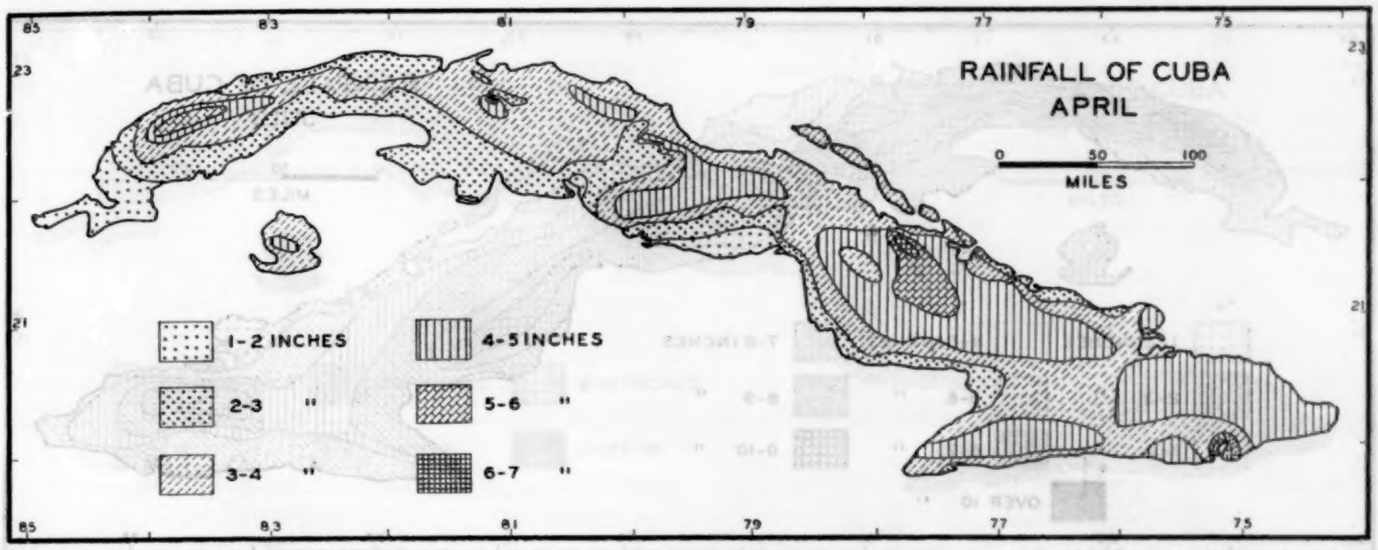
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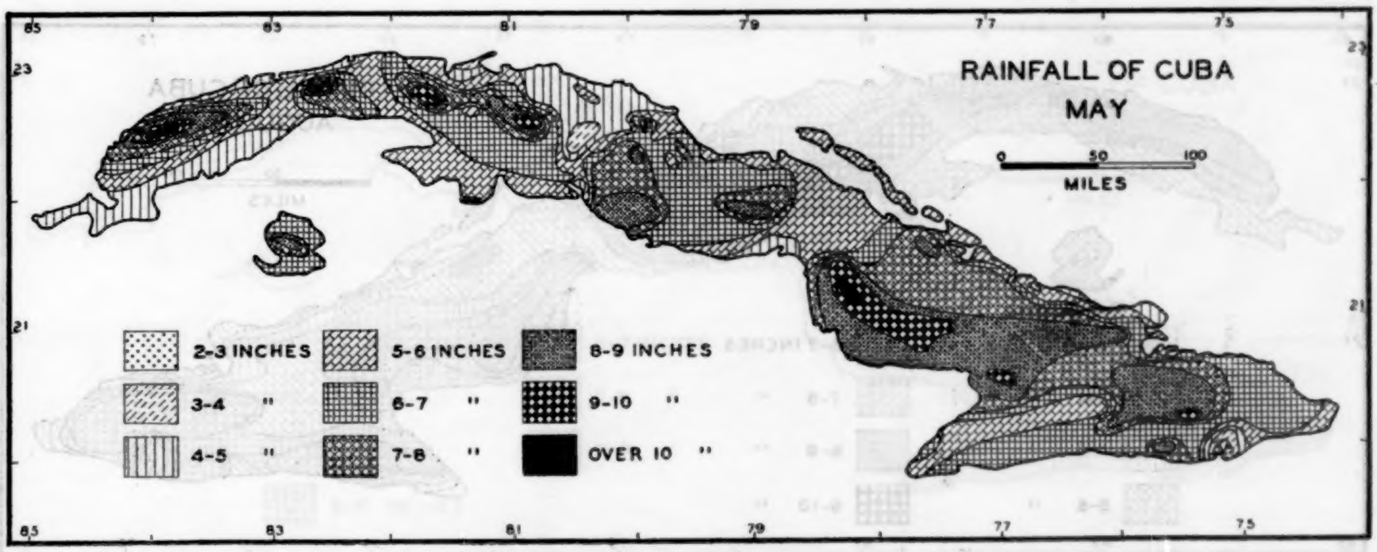
23
21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8-9 INCHES
9-10 "
OVER 10 "
85 83 81 79 77 75
23
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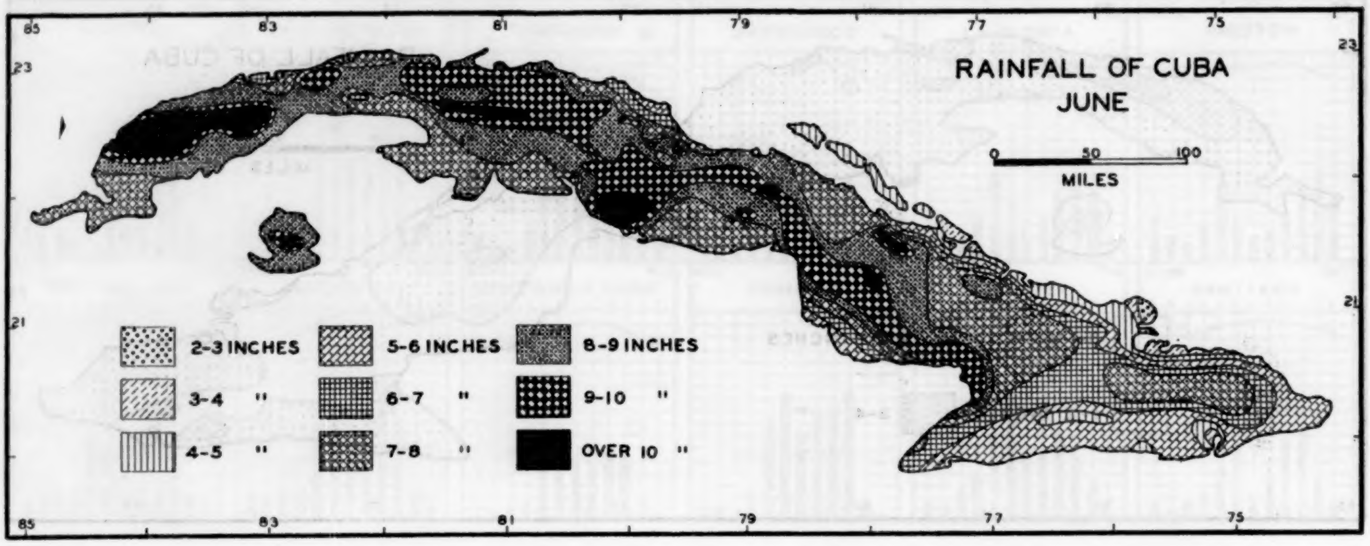
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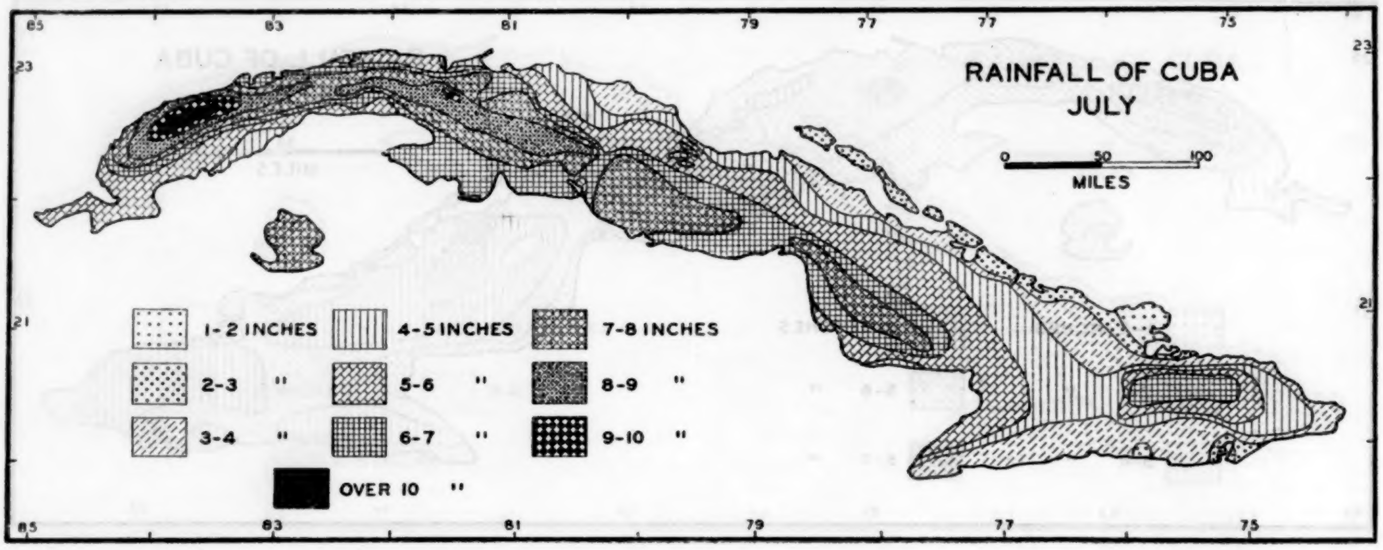
OVER 10 "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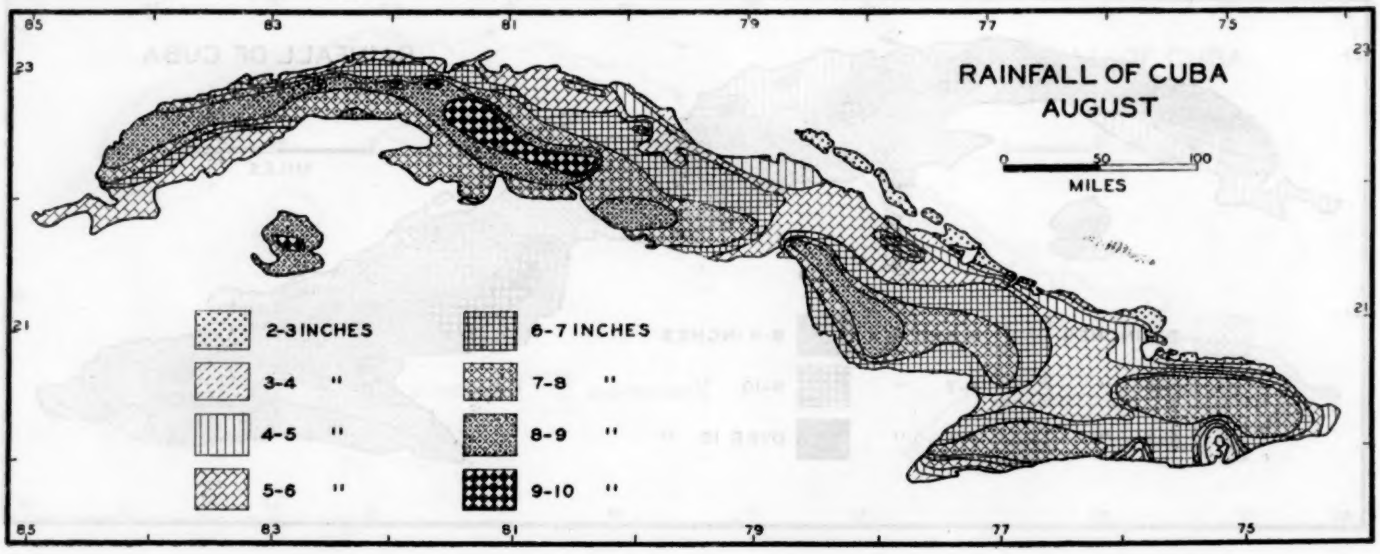
OVER 10 "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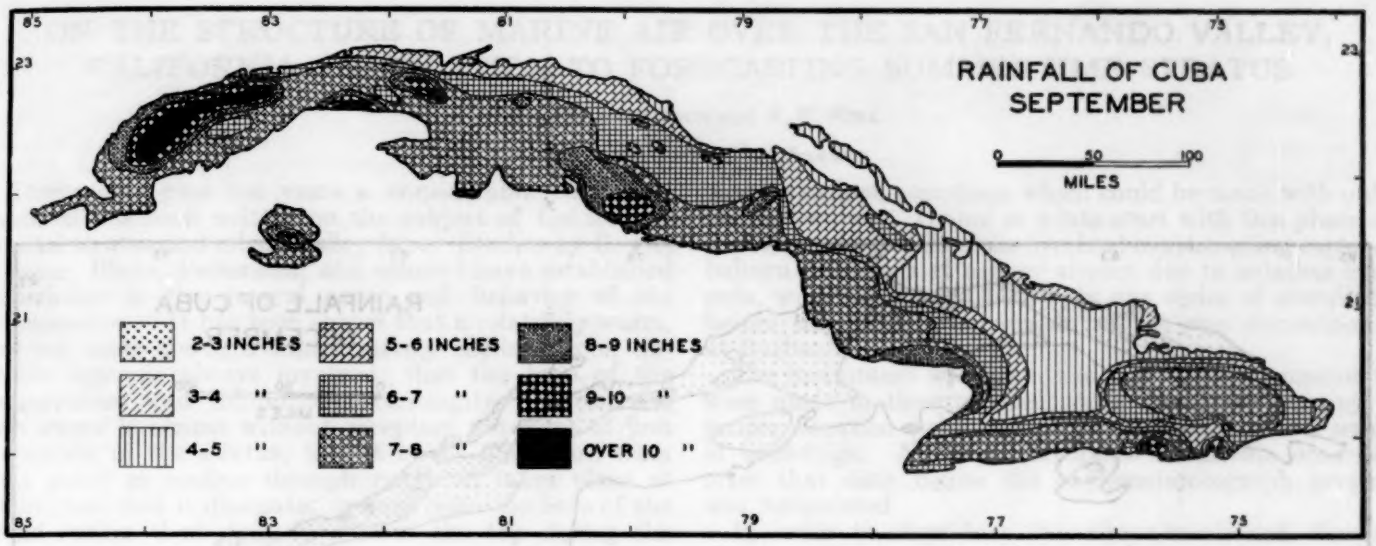
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3-4 "
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8-9 INCHES
9-10 "
OVER 10 "
85
83
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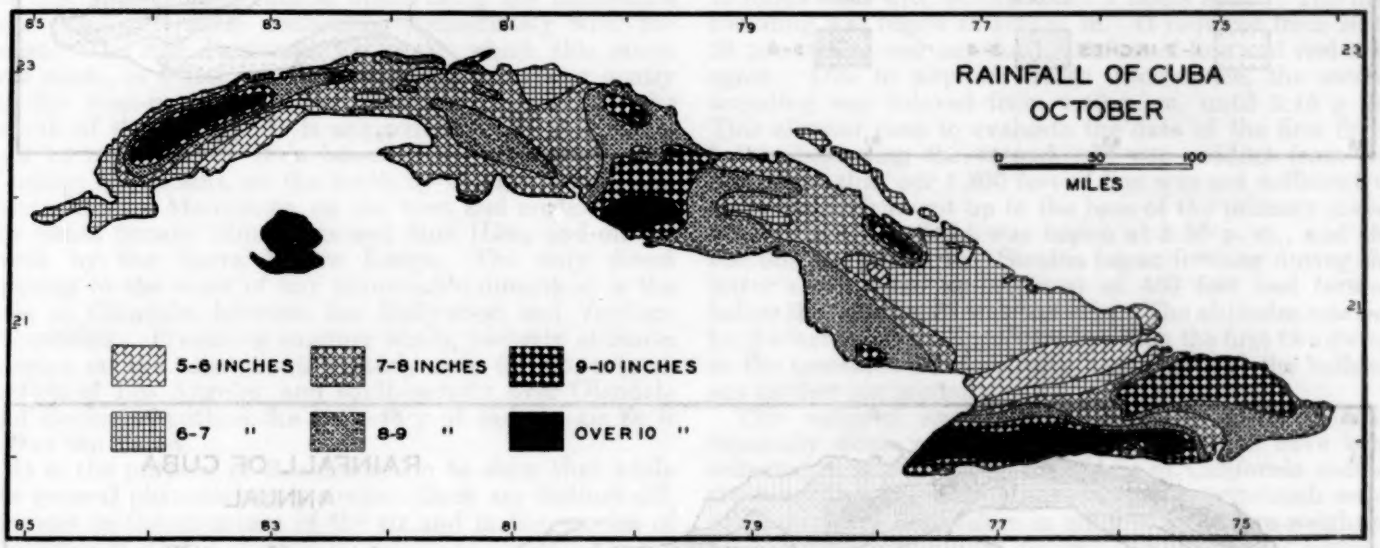
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MILES
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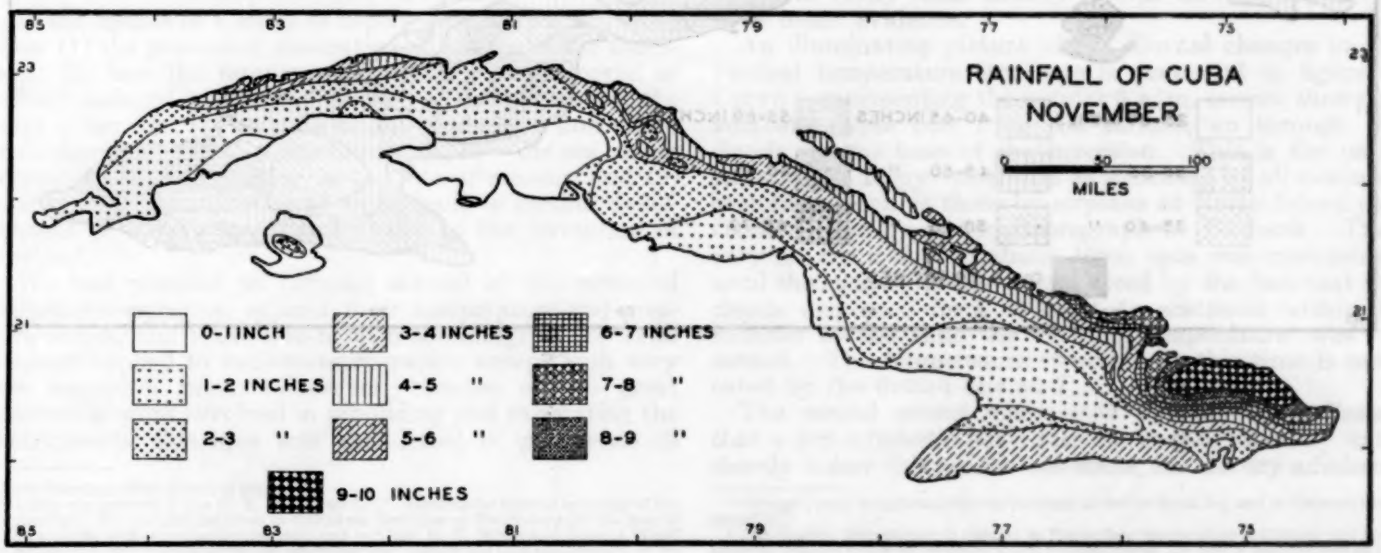
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MILES
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2-3 "
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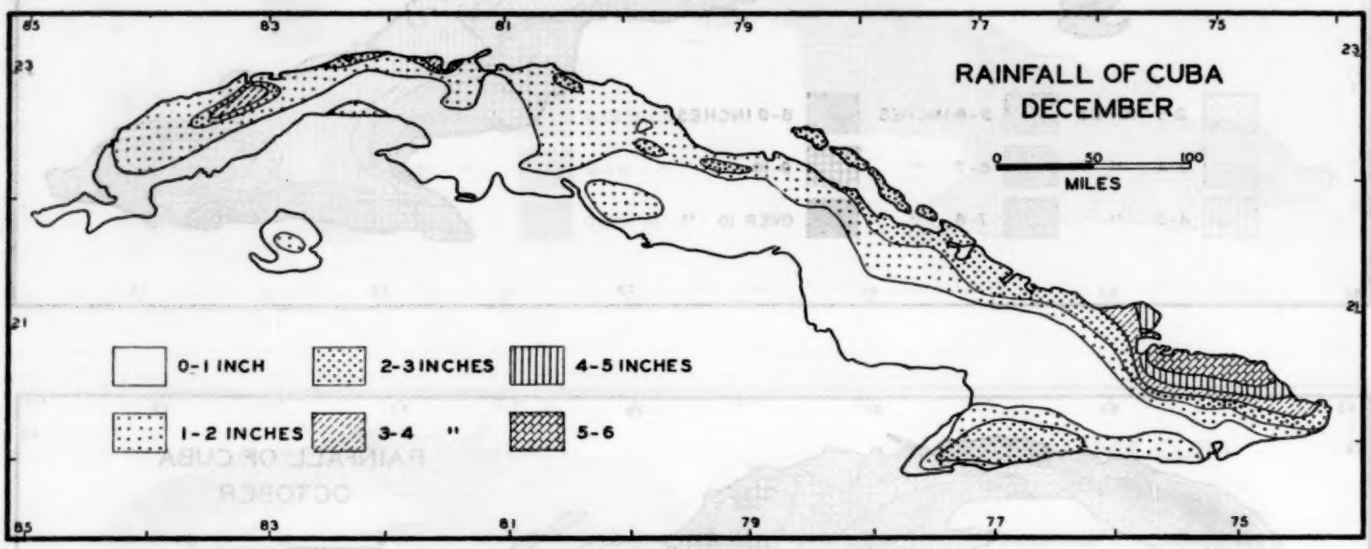
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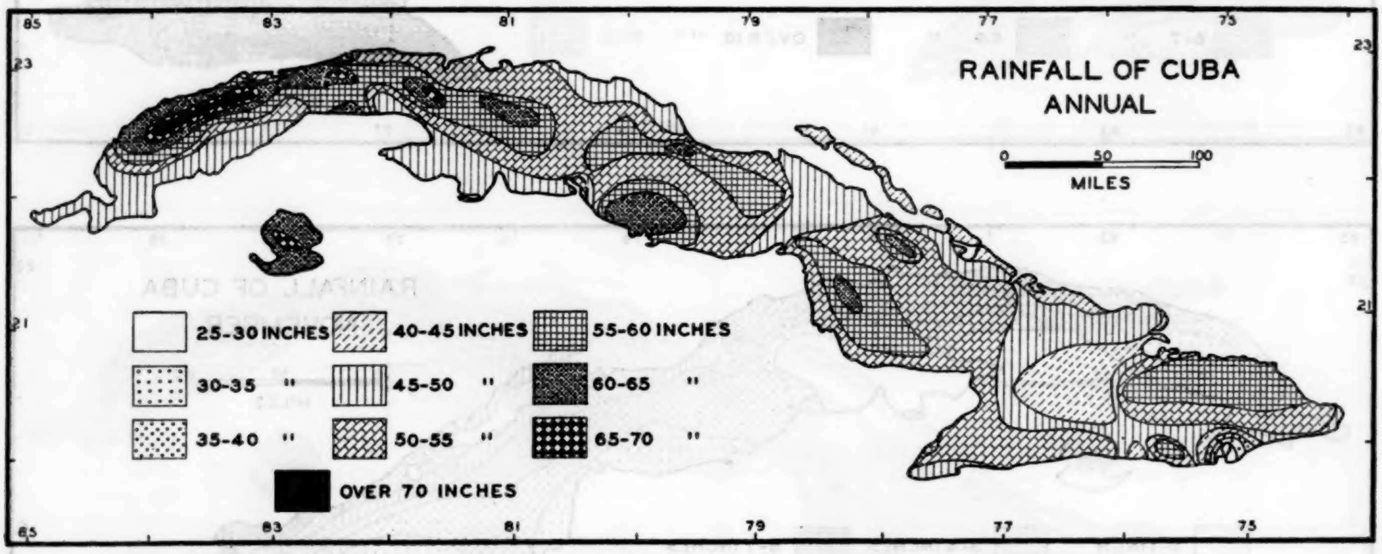
RAINFALL OF CUBA
ANNUAL
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35-40 "
40-45 INCHES
45-50 "
50-55 "
55-60 INCHES
60-65 "
65-70 "
OVER 70 INCHES

ON THE STRUCTURE OF MARINE AIR OVER THE SAN FERNANDO VALLEY, CALIFORNIA, IN RELATION TO FORECASTING SUMMERTIME STRATUS

By H. E. HUTCHISON and K. C. FINK

[Weather Bureau, Burbank, Calif., June 1939]

During the past ten years a considerable volume of material has been written on the subject of California's coastal stratus and inland valley fogs. Studies by Bowie, Vernon, Blake, Petterssen, and others[1] have established knowledge of the general cause and behavior of the phenomenon. It has been shown that a relatively warm, dry air mass above a comparatively shallow, cool, unstable layer is always involved; that the base of the temperature and humidity discontinuity between the two strata is almost without exception the point of first formation of the stratus; that it builds downward from that point as cooling through radiation takes place at night; and that it dissipates upward from the base of the cloud rather than downward from the top during the day.

The whole subject has heretofore been studied mainly on the basis of observations made along the immediate coast and over areas connecting immediately with the coast. The San Fernando Valley, in which this study was made, is a flat valley broadening and rising gently to the west-northwest from Glendale, located in the mouth of the valley. It is approximately 20 miles long and 10 miles wide. It is bounded on the east by the Verdugo Mountains, on the south by the Hollywood and Santa Monica Mountains, on the west and northwest by the Santa Suzana Mountains and Simi Hills, and on the north by the Sierra Madre Range. The only direct opening to the coast of any appreciable dimension is the pass at Glendale, between the Hollywood and Verdugo Mountains. Prevailing summer winds, westerly at Santa Monica on the coast, southwesterly over the down-town section of Los Angeles, and southeasterly over Glendale and Burbank, outline the trajectory of the sea air as it enters the Valley.

It is the purpose of this discussion to show that while the general phenomenon is similar, there are distinct differences in the structure of the air and in the process of formation of stratus overcoastal valleys as compared to the immediate coast; and to comment on methods of forecasting time of development and dissipation. We present here the results of a series of captive-balloon soundings to show (1) the process of dissipation of stratus in the mornings; (2) how the temperature inversion is destroyed or greatly reduced by heating of the valley floor during the early afternoon; (3) how the height of the inversion varies with changing surface temperature; (4) how the sea breeze reestablishes the inversion in the late afternoon; and (5) how subsequent radiation at night leads to further development of the inversion and finally to the formation of stratus.[2]

We had planned to remodel several of the returned radiometeorographs, expand their temperature and pressure scales, and make free-balloon soundings in the usual manner applied to radiometeorographs, except with very low ascension rates. However, because of the great amount of work involved in rebuilding and calibrating the instruments, this idea was abandoned in preference to captive-balloon soundings which could be made with only one instrument. Owing to a late start with this phase of the study and to difficulties involved in attempting captive-balloon soundings at a busy airport due to aviation hazards, we were able to take only one series of soundings before the radiometeorograph project was discontinued at Burbank.

The instrument was remodeled and other arrangements were made in time to select June 16 as representing a proper situation (with regard to the stratus) for a series of soundings. No other favorable conditions occurred after that date before the radiometerorograph project was terminated.

In order to show how the above-mentioned diurnal changes take place, the plan was to take the first sounding as near the time of maximum temperature as possible and to follow that with others about 3 hours apart. The first sounding was begun at 1:40 p. m. It required from 20 to 25 minutes to reel out the 1,800 feet of line and reel it in again. Due to airplane traffic interference, the second sounding was delayed from 4:40 p. m. until 5:15 p. m. This allowed time to evaluate the data of the first flight before beginning the second. It was evident from the first flight that our 1,800 feet of line was not sufficient to carry the instrument up to the base of the primary inversion. The third flight was begun at 8:55 p. m., and the last one at 10:28 p. m. Stratus began forming during the latter ascent, and an overcast at 400 feet had formed before the instrument was reeled in. The altitudes reached by the last two soundings were less than the first two owing to the increased wind velocity which carried the balloon out farther horizontally.

This series of soundings is very interesting of itself, especially since very little data of this kind have been collected in relation to the problem of California coastal stratus. It is regrettable that more than one such series could not have been taken in order to add more weight to the arguments presented below. Although this series is given a leading place in this discussion, in reality it only serves to verify ideas already formed through experience with other evidence.

An illuminating picture of the diurnal changes in the vertical temperature structure is presented in figure 1. Curve 1, representing the regular 6 a. m. ascent, shows an adiabatic lapse rate from the surface, up through the clouds, to the base of the inversion. This is the usual situation on foggy[3] mornings as indicated by all available soundings, such as those by airplane at North Island and Oakland and by radiometeorograph at Burbank. That very nearly a dry adiabatic lapse rate was maintained until the stratus cleared is evidenced by the fact that the clouds decreased from overcast to scattered within 15 minutes of the time the clearing temperature[4] was recorded. The temperature structure at this time is indicated by the dotted line at T_c.

The second ascent represented by curve 2, indicates that a dry adiabatic lapse rate continued, probably until shortly before this ascent was made; for the dry adiabatic

[1] See literature cited at end of paper.

[2] Acknowledgement is due H. R. Byers and L. P. Harrison for helpful criticism of the manuscript. We are also indebted to California Institute of Technology for the loan of their receiving and recording equipment, and to Capt. O. C. Maier and Louvan Wood for advice and assistance with the radiometerograph; also for the able assistance of H. C. Harvey and C. A. Cole in making the soundings.

[3] "Foggy", used to indicate high fog (stratus) as well as dense fog, and in the same sense hereafter.

[4] The clearing temperature is defined as the surface temperature (assuming dry adiabatic conditions) which corresponds to the temperature at the base of the inversion at the time of clearing.

lapse rate which exists above point C_2 could only have been established by a vertical transport of heat from the surface. It appears reasonable, in view of the uniform wind direction, to conclude that the base of the inversion has now risen to point L.

The base of the inversion has risen as a result of insolation, and by this time has reached a point which no longer bears any relationship to the depth of the sea breeze; for the depth of the sea breeze is a function of the onshore pressure gradient. In this connection, we note that an interesting development has begun, namely, the appearance of a minor inversion at B_2. An analysis of curve 2 shows first, a shallow layer A_2B_2 characterized by a super adiabatic lapse rate, then an isothermal layer B_2C_2, and finally, a layer above C_2, presumably extending rapidly at points B_2 and B_3 than at the surface. At point D, the existence of a sharp inversion and an abrupt shift in the wind direction from southeast to northwest, which was absent on the second ascent, is noted. The northwesterly wind represents advection of air which has been heated by contact with a warm surface. This warm surface could well have been the upper portion of the coastal hills, which become intensely heated through insolation due to the relatively clear atmosphere above the surface layer. The coastal hills (Hollywood and Santa Monica Mountains) extent in a general west-northwest direction along the south side of the San Fernando Valley, paralleling the coast line and hence a northwest wind at Burbank could have had an appreciable history over land surface before reaching Burbank.

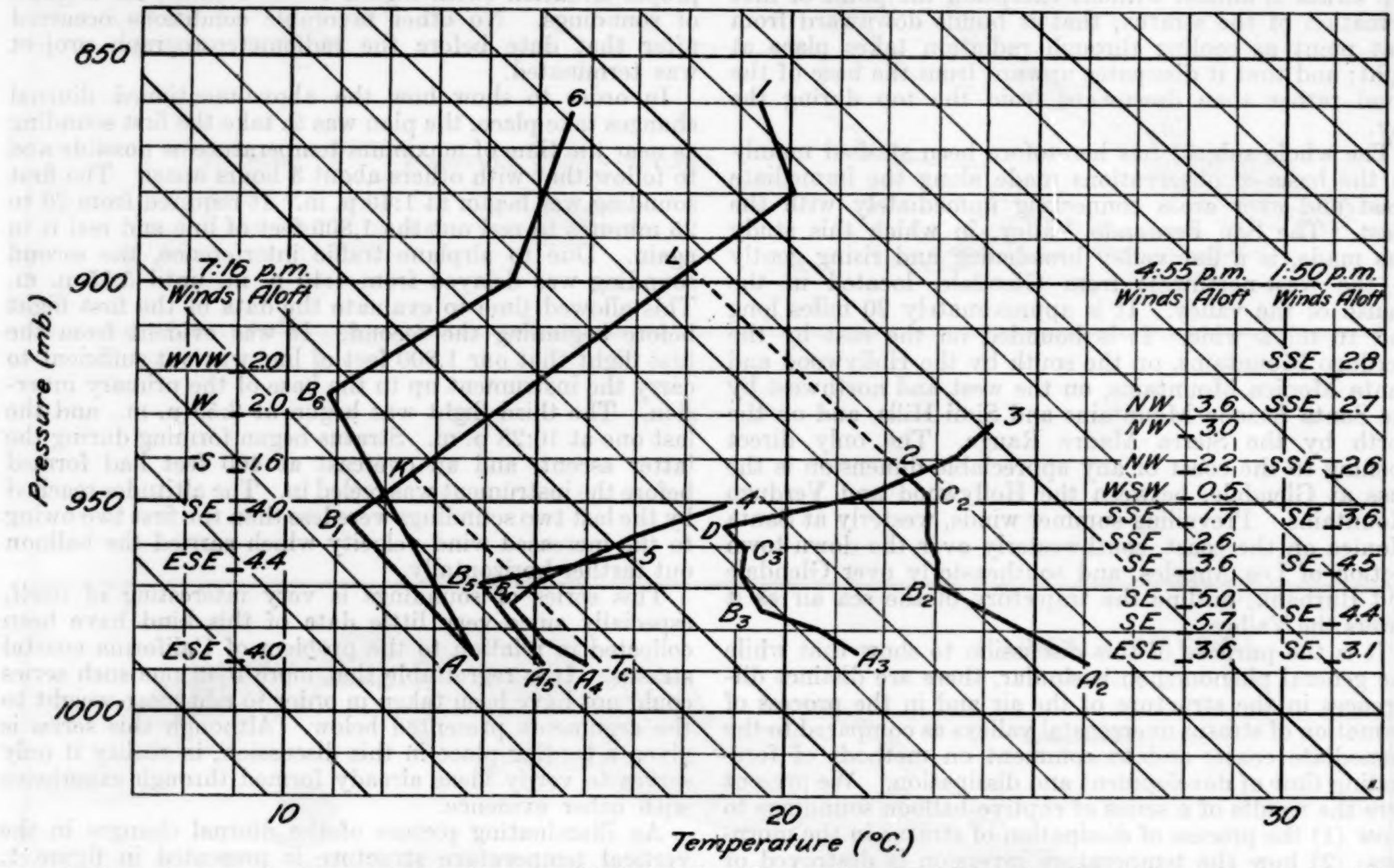

FIGURE 1.—Temperature curves of radiometeorograph soundings on an adiabatic chart: Free-balloon soundings, curves 1 (6 a. m., June 16) and 6 (6 a. m., June 17); captive-balloon soundings, curves 2 to 5 inclusive, at 1:40 p. m., 5:15 p. m., 8:55 p. m., and 10:28 p. m.

to L, with a dry adiabatic lapse rate. The corresponding upper air winds indicate that while a uniform direction prevails throughout, the greatest velocity is from point B_2 to near the surface. We shall consider then that point B_2 represents the top of the fresh sea breeze and that the layer B_2C_2 represents a mixing zone between the fresh and old marine air.

The third ascent up to point D, shows the same structure with respect to temperature and wind as the second ascent. The actual values of temperature are approximately four degrees cooler. This can be accounted for best as the result of advection; for there normally exists a marked temperature gradient from the interior to the coast, and a southeast wind being a sea breeze tends to lower the temperature. The super-adiabatic lapse rate in the surface layer on each of these ascents can perhaps be attributed to the intense rate of heating at the ground, and to the fact that advection was proceeding more

By the time of the fourth ascent the minor inversion at B_2 and B_3 has now become a marked inversion at B_4. That this inversion does not correspond to D of the previous ascent is illustrated by the fact that the southeasterly current extends beyond point B_4, whereas at D there was an abrupt change in the direction of the wind. It is also worthy of note that the amount of cooling at the various levels between the third and fourth ascents is roughly proportional to the wind velocities of the 4:55 p. m. observation.

The fifth ascent is similar to the fourth except for a slight increase in the elevation of the base of the inversion. The rate of cooling between the fourth and fifth ascents has diminished considerably from that between the previous ones. A brief consideration of the temperature gradient between Burbank and the coast will clarify this decreased rate of cooling. The maximum temperature gradient from Burbank to the coast occurs simul-

taneously with the maximum temperature at Burbank, and conversely, the minimum near the time of minimum temperature. Therefore, with a uniform flow of air from the coast we should expect the greatest rate of cooling near the time of maximum temperature, other things being equal. Actually, the problem is not so simple due to the factors of insolation and radiation. In this case the greatest rate of cooling occured between the third and fourth ascents.

Stratus clouds formed while the fifth ascent was being made. The first ceiling height was 400 feet, and this agrees closely, assuming the stratus to be about 100 feet thick, with the inversion at B_5. Another significant fact is that a dry adiabatic lapse rate was maintained after nightfall from the surface up to point B_5. Some have been of the opinion that after nightfall a ground inversion will rapidly develop in the absence of clouds. This observation would tend to indicate that the haze layer, which is always prevalent preceding the formation of stratus, is sufficient to prevent the development of a ground inversion. The average temperature-dewpoint difference [5] in relation to ceiling height at the time stratus first forms also indicates that approximately a dry adiabatic lapse rate prevails from the surface to the clouds.

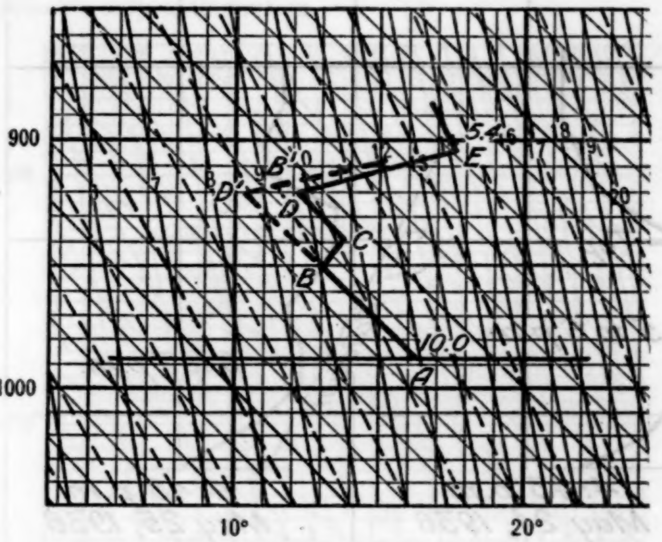

FIGURE 2.—Illustration on pseudoadiabatic chart of a method whereby the top of the stratus may build up.

The remarkable increase in depth of the stratus clouds and the attendant rise in the top, as indicated by the regular ascent of the following morning, was due to an increased onshore pressure gradient resulting from cyclogenesis over the plateau. This increase in depth always occurs with the development of a low pressure area over the plateau, sometimes with astonishing rapidity.

The frequent persistence of haze in the San Fernando Valley during the late morning and afternoon has been rather baffling. One would assume that, with comparatively intense solar heating of the valley floor, an adiabatic lapse rate would prevail through out a considerable depth and therefore the haze would be carried aloft, resulting in greatly improved visibility. However, the presence of low level minor inversions, as found by the writers, will account for the frequent persistence of the haze, for they effectively hinder its vertical distribution.

[5] The average amount of ceiling per ° F. depression of the dew point for the 5-year period, 1933-37, for June, is 275 feet. This value was determined for the time stratus first formed in the evening, and for ceilings from 100 to 3,000 feet. Assuming a dry adiabatic lapse rate, the amount is 227 feet per ° F.

Since the synoptic developments from the afternoon of June 16 until the morning of the 17th were not typical of the usual, it is thought fitting to describe briefly the "normal" behavior of the stratus. We do not wish to infer that there is not often considerable variance in the behavior of the tratus but merely that there is a type of behavior occurring with sufficient frequency to be considered a normal condition.

In general, the top of the stratus is at about the same elevation for several successive mornings, while the ceiling when the stratus first forms may vary appreciably. It also is very noticeable that the first ceiling in the evening is much lower than the last ceiling before clearing of the same morning, and also considerably lower than the top of the stratus before sunrise the next morning.[6] Under these circumstances, the behavior of the stratus is indeed difficult to explain from the prevalent idea of a single inversion; for in that case the stratus should first form at the base of the inversion and gradually work down so that the top could not rise.

By means of the double inversion structure (see fig. 2) many variations in the behavior of the stratus may be accounted for.[7] For example, stratus may form first at the base of the minor inversion, created as previously described, through advection, while at the same time considerable radiational cooling is presumably occurring at point *D*, the point of maximum moisture contrast. Now point *D* may undergo sufficient cooling to reach point *D'*, thereby establishing a continuous adiabatic lapse rate from *D'* to the surface; and hence a building up of the stratus to *B'* will occur, assuming moist adiabatic conditions within the cloud. It is probable that cooling from *D* completely to *D'* would not be necessary to allow for the clouds to build upward. It would need cool only sufficiently for slight turbulence to penetrate the diminishing inversion at *B*.

A rather complex vertical temperature structure in the afternoon was first indicated in the spring of 1936 when, through the courtesy of United Air Lines, we were furnished temperature readings at 200-foot intervals. A few of these are reproduced in figure 3. The single horizontal line indicates the level at which stratus first formed; the double horizontal line the level of the top of the stratus on the following morning.

The problem of forecasting the time of development and the height of stratus for areas along the immediate coast of California has its difficulties, but for coastal valleys at an appreciable elevation above sea level, such as the San Fernando Valley, the problem is more complex. The stratus forms along the immediate coast presumably as a result of turbulence and radiational cooling in the moist surface layer. Over coastal valleys, however, advection plays an important role. Therefore, a forecast for these areas must be approached through an understanding of the situations under which advection of moist or dry air takes place, as well as the effects and extent of turbulence and radiation. We shall comment on the general aspects of the problem without discussing any particular situation in detail.

It is not an easy matter to estimate the rate of flow of the moist air inland. The surface pressure gradient is so badly distorted by the effects of the mountains and the heating in the desert valleys that the true pressure gradient is very difficult to evaluate. The normal pressure gradient along the coast in summer calls for

[6] The average difference between the last ceiling in the morning and the first ceiling of the following night, for the four year period, 1934-37, for June, is 447 feet. See also fig. 3.

[7] Bowie, Vernon, and Petterssen all mention the double inversion in their studies of the stratus but apparently they regard it as an exceptional case rather than the rule, such as seems to be the case in the San Fernando Valley.

winds from northwest to west. Yet, in the San Fernando Valley the prevailing direction in summer is southeast—directly opposite to the indicated gradient. This is due to the deflection of the flow by the mountain ranges that inclose the San Fernando Valley.[8] The marine air can not reach the Valley by flowing directly over the mountains owing to the "lid effect" of the warm air above it except when the marine air extends well above the elevation of these mountains. It must either flow up the circuitous course of the Los Angeles River or through a few, narrow, low passes. All these obstructions greatly complicate the rate of flow. A careful study of wind data, both surface and aloft, affords a vague means of reaching an estimation. Wind data are not available in sufficient detail to make a complete picture possible.

no direct evidence is available to the forecaster at the time of the evening forecast as to the structure of the air over the area with which he is concerned. The absence of direct aerographic measurements at appropriate times has forced the forecaster to resort to whatever indirect methods he can devise. Vernon's use of pressure comparisons between Eureka and Oakland in order to estimate the depth of the moist layer over Oakland is an attempt along these lines. Once the height of the single inversion above the coastal station is determined, assuming an adiabatic lapse rate within the stratum, it is a simple task, with the aid of a pseudoadiabatic diagram and any concurrent, early evening temperature, dew point, and pressure, to locate the height of the condensation level with respect to the base of the inversion. The time of

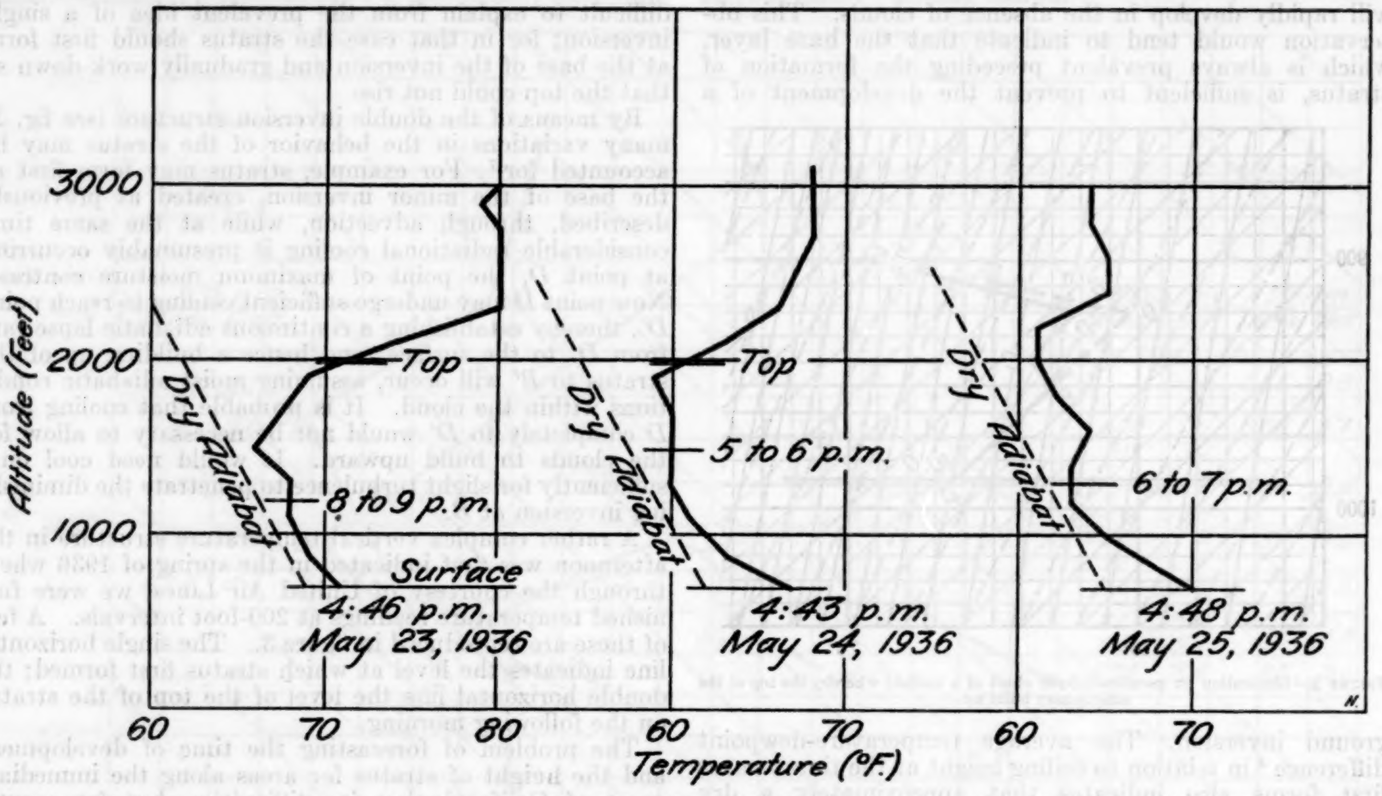

FIGURE 3.—Temperature-altitude curves of data received from air line pilots. The thickness of the cloud layer is much greater on the 25th under the influence of a deepening low pressure trough over the plateau.

Knowledge as to the thickness of the moist stratum, the lapse rate within it, and the moisture distribution above the marine layer, as well as within it, can only be had by means of aerographic soundings. The series of soundings represented in figure 1 is enough to indicate that one sounding a day taken in the morning is a poor indicator as to what can be expected for the coming evening. For purposes of forecasting time of development of the stratus and its height, the most opportune time for a sounding is 3 to 4 hours after the time of maximum temperature. It is only in this way that the changes brought about by insolation, mixing, and later advection of fresh marine air can be evaluated with any degree of accuracy. The morning sounding is of value primarily for forecasting time of clearing of the cloud.

Except for the temperature data available only irregularly from pilots' observations taken over the Airport in departing or arriving on regular scheduled airline trips,

condensation is then forecast from an estimation of the rate of lowering of surface temperature, since the cloud first forms at the top of the marine layer.

In connection with determining the height of the condensation level from surface data, Lt. Floyd B. Wood found, in his study on "The Formation and Dissipation of Stratus Clouds Beneath Turbulence Inversions," that the computed condensation level is usually lower than the observed cloud base. Some allowance must be made accordingly in the computed value. For levels below 500 meters, his curves show that the necessary allowance is very small. In the great majority of cases in the San Fernando Valley, the condensation level is below 500 meters.

Although a considerable amount of investigation has been done at Burbank with hope of discovering some such dependable relation as Vernon [9] found between pressure difference at Eureka and Oakland, and the depth of the

[8] A good description of the topography of the region is given by H. R. Byers—Characteristic Weather Phenomena of California.

[9] E. M. Vernon—The Diurnal Variation of Ceiling Height Beneath Stratus Clouds, Monthly Weather Review, Jan. 1936.

sea breeze, no reliable relation has been found so far. Reference to the series of soundings herein described may well suggest a cause for this failure. The complexity of a double inversion, such as seems to be a frequent case at Burbank, makes comparison of pressures in estimating the depth of the sea breeze too delicate to be detectable above the greater effects on pressure of heating in mountain valleys, of reduction to sea level, etc. Brown of the Burbank Office of the Weather Bureau has made an extensive study of the relation of pressures at Burbank and those at stations in the San Joaquin Valley, and Colorado River Valley, and along the coast, as to the *time of formation* of stratus at Burbank. His curves give favorable results when used together with a night to night comparison of the general synoptic situation. His comparisons are extremely delicate in some cases; for example, each 0.01 inch lower pressure at Fresno than at Burbank gives, on the average, a one hour earlier development of the cloud. Furthermore, the frequent large departures of individual cases from the average, makes use of his data advisable only with caution.

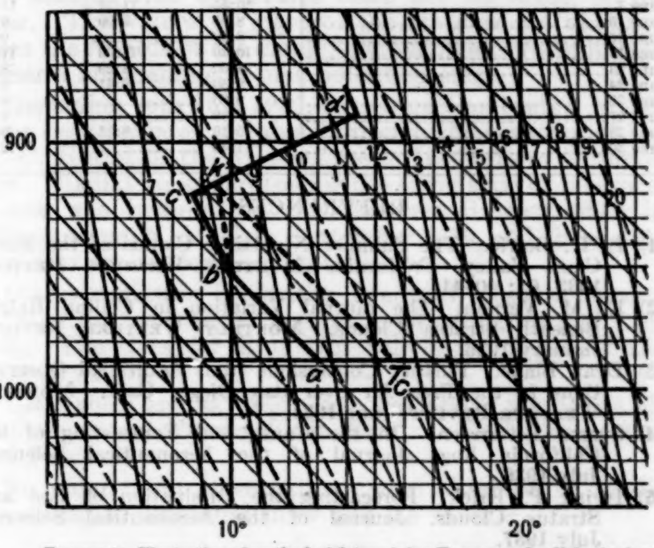

FIGURE 4.—Illustration of method of determining T_c on pseudoadiabatic chart.

The problem of forecasting the clearing of summertime stratus at Burbank has received considerable study during the past 2 years. Previously, the problem of forecasting the formation of these clouds was receiving most of the attention of the forecasters. This was largely because the forecasts for clearing were generally more accurate than were those for forming.

The first approach to the present method of forecasting clearing came with the use of the pseudoadiabatic chart. With the aid of this chart it was noted that the surface temperature at which the clouds began to break could often be determined within reasonable limits.

Occasionally forecasts were based on estimations of the time the clearing temperature, T_c, would be reached. This was done by noting the temperature behavior on a previous foggy day. However, variability in temperature behavior on individual days gave rather discouraging results. It was finally decided to prepare some average temperature curves (described below) whereby the time of clearing could be determined from the value of T_c.

Since this method of forecasting the clearing of stratus clouds has been previously described elsewhere,[10] this section will be devoted mostly to the application of this method in daily use and to some results obtained thereby.

[10] Dr. Irving P. Krick, Journal of the Aeronautical Sciences, July 1937, p. 12.

The method of determining T_c is illustrated in figure 4. The curve *abcd* is the temperature curve on the pseudoadiabatic chart. Point *a* represents the surface temperature, *b* the temperature at the base of the clouds, *c* the temperature at the top of the clouds and base of the inversion, and *d* the temperature at any point in the inversion layer which is sufficiently above *c* to remian above the clouds until they have dissipated. The point *k* is determined by drawing through *b*, a line parallel to the nearest specific humidity line on the chart. This line intersects *cd* at *k*. From *k* the dotted line follows a dry adiabatic path to the surface where T_c is indicated. Once T_c has been determined, the clearing time can be ascertained by means of curves such as shown in figure 5.

These curves represent the average hourly change in temperature, based on 6 years of record, when low stratus clouds or dense fog prevailed. A separate curve was prepared when each of the following conditions prevailed from 5 a. m. to 6 a. m.: (1) Dense fog, (2) Stratus with ceiling approximately 500 feet, (3) Stratus with ceiling approximately 1,000 feet, and (4) Stratus with ceiling

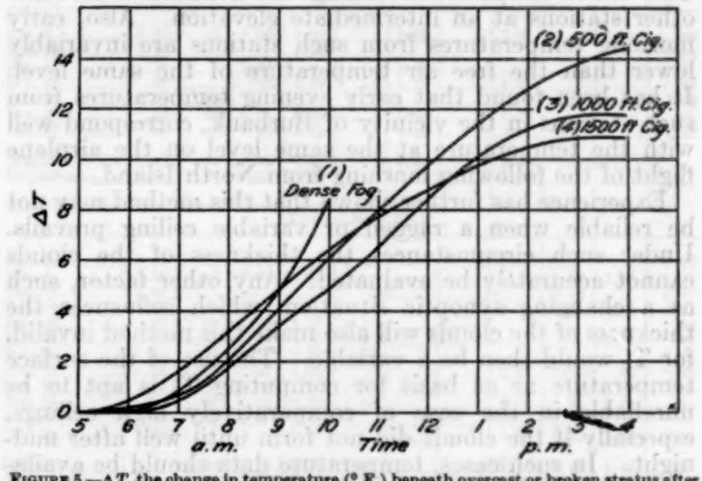

FIGURE 5.—ΔT, the change in temperature (° F.) beneath overcast or broken stratus after 5 a. m., is plotted as ordinates and time as abscissas.

1,500 feet to 2,000 feet. The relative steepness of the curves, with the exception of the 5 a. m. to 9 a. m. portion of curve 4, is what one would expect, since with increasing ceiling a deeper column of air must be heated in order to raise the surface temperature 1°. In the case of the higher ceilings, it is probable that a weak ground inversion develops, and that the initially greater slope represented in curve 4 is due to the rapid disappearance of this inversion after sunrise.

It should also be pointed out that these curves may be used for estimating the time that any given ceiling will be reached. One degree Centigrade increase in temperature represents a theoretical increase in ceiling of about 115 meters, which is equivalent to 210 feet per degree Fahrenheit.

If airplane observations or radiometeorograph observations are available, it is a very simple task requiring but a few seconds to determine T_c after the data have been plotted on a pseudoadiabatic chart. Further, data secured by these means are sufficiently accurate to allow for very reliable determinations of T_c. Hence, any deviation in the indicated clearing time from the actual will have but one source of error, namely, the temperature curves. This source of error is unfortunately unavoidable.

If radiometeorograph or airplane observations are not available, the method may still be used with good results provided accurate information can be had as to the ceil-

ing and thickness of the clouds, and the slope of the lapse rate in the inversion layer. For any given surface temperature, T_c varies directly with (1) the thickness of the clouds and (2) the steepness of the slope of the lapse rate curve in the inversion layer, as can be seen from figure 5. However, without accurate information no attempt should be made to use this method. It should be pointed out also that the application of this method assumes that the specific humidity remains fairly constant during the clearing process.

This information may often be had from scheduled airline pilots, a very satisfactory source. Also nearby mountain stations can give this information, though in general, due to the fact that the elevation of the top of the clouds has to be estimated, the results therefrom are not always reliable. For example, an error of 500 feet in estimating the elevation of the top of the clouds will give a very unsatisfactory value for T_c. It is also often difficult to get an accurate concept of the lapse rate in the inversion layer; for the mountain station may be above the inversion layer, in which case this method cannot be used unless temperature readings are available from some other stations at an intermediate elevation. Also, early morning temperatures from such stations are invariably lower than the free air temperature of the same level. It has been found that early evening temperatures from such stations in the vicinity of Burbank, correspond well with the temperature at the same level on the airplane flight of the following morning from North Island.

Experience has further shown that this method may not be reliable when a ragged or variable ceiling prevails. Under such circumstances the thickness of the clouds cannot accurately be evaluated. Any other factor, such as a changing synoptic situation, which influences the thickness of the clouds will also make this method invalid, for T_c would then be a variable. The use of the surface temperature as as basis for computing T_c is apt to be unreliable in the case of comparatively high ceilings, especially if the clouds did not form until well after midnight. In such cases, temperature data should be available from the top or base of the cloud layer in order to compute T_c.

Some results are presented in table 1. It was decided to use for this purpose the results obtained during May and June of 1938, a period when daily morning radiometeorograph observations were made at Burbank, and hence a period during which no doubt can exist as to the reliability of the source of the data. Under the heading, T_c, is the indicated time of clearing, and under the headings, BRKN, and SCTD, the time at which the clouds first became broken and scattered respectively. While the results are by no means perfect, broken or scattered clouds were reported within 1 hour of the indicated clearing time in approximately 80 percent of the cases, and in all cases within 1½ hours of the indicated clearing time. We therefore believe these results justify the use of this method of forecasting the clearing of California summertime stratus clouds.

TABLE 1

Date	t_c	BRKN	SCTD
	a. m.	a. m.	a. m.
May 11	7:20		8:10
May 12	8:10		8:41
May 13	8:00	8:41	8:45
May 14	8:30	9:15	9:41
May 16	None		
June 2	8:40		7:29
June 3	8:35		8:25
June 6	8:35	9:00	9:10
June 7	10:55	11:29	11:34
June 15	8:35	9:00	9:04
June 16	8:30		9:55
June 17	10:40	11:00	11:10
June 23	8:00	8:29	8:41
June 24	8:30	9:41	9:50
June 25	9:00		9:09
June 27	7:30		8:06
June 28	10:10	8:15	9:50
June 30	11:40		12:55

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By AMY P. LESHER

(This section will be resumed in the March issue—Editor.)

SOLAR OBSERVATIONS

[Meteorological Research Division, EDGAR W. WOOLARD in charge]

SOLAR RADIATION OBSERVATIONS, OCTOBER 1939

By IRVING F. HAND

Measurements of solar radiant energy received at the surface of the earth are made at nine stations maintained by the Weather Bureau, and at ten cooperating stations maintained by other institutions. The intensity of the total radiation from sun and sky on a horizontal surface is continuously recorded (from sunrise to sunset) at all these stations by self-registering instruments; pyrheliometric measurements of the intensity of direct solar radiation at normal incidence are made at frequent intervals on clear days at three Weather Bureau stations (Washington, D. C., Madison, Wis., Lincoln, Nebr.) and at the Blue Hill Observatory at Harvard University. Occasional observations of sky polarization are taken at the Weather Bureau stations at Washington and Madison.

The geographic coordinates of the stations, and descriptions of the instrumental equipment, station exposures, and methods of observation, together with summaries of the data, obtained up to the end of 1936, will be found in the MONTHLY WEATHER REVIEW, December 1937, vol. 65, pp. 415 to 441; further descriptions of instruments and methods are given in Weather Bureau Circular Q.

Table 1 contains the measurements of the intensity of direct solar radiation at normal incidence, with means and their departures from normal (means based on less than 3 values are in parentheses). At Madison and Lincoln the observations are made with the Marvin pyrheliometer; at Washington and Blue Hill they are obtained with a recording thermopile, checked by observations with a Marvin pyrheliometer at Washington and with a Smithsonian silver disk pyrheliometer at Blue Hill. The table also gives vapor pressures at 7:30 a. m. and at 1:30 p. m. (75th meridian time).

Table 2 contains the average amounts of radiation received daily on a horizontal surface from both sun and sky during each week, then departures from normal and the accumulated departures since the beginning of the year. The values at most of the stations are obtained from the records of the Eppley pyrheliometer recording on either a microammeter or a potentiometer.

Beginning with July 1939, data from Cambridge, Mass., have been included in table 2 through the courtesy of Dr. H. C. Hottel of the Massachusetts Institute of Technology. Radiation apparatus for the same type of measurements was installed at the Weather Bureau office in Albuquerque, N. Mex., in September 1939, and these data now also appear regularly in table 2.

Direct radiation intensities averaged close to normal at Madison and below normal at Washington and Lincoln. The data for Blue Hill will be published in the February Review.

Total solar and sky radiation was above normal at all stations except Fresno, Twin Falls, La Jolla, Riverside, and Newport.

No polarization observations were obtained at Madison owing to continual snow and ice cover.

TABLE 1.—*Solar radiation intensities during January, 1940*

[Gram-calories per minute per square centimeter of normal surface]

Date	7:30 a.m.	Sun's zenith distance									1:30 p.m.
		78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	
	75th mer. time	Air mass									Local mean solar time
		A. M.					P. M.				
	e	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e
WASHINGTON, D. C.											
	mm.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm.
Jan. 3	1.45				1.36						1.45
Jan. 9	1.28	0.72	0.92	1.10	1.32						1.88
Jan. 10	2.26				1.26						2.06
Jan. 16	1.78	.80	.88	.95	1.26						1.60
Jan. 22	1.52				1.51						1.52
Jan. 25	1.32	.59	.78								1.24
Jan. 26	1.02				1.25						.86
Means		.77	.86	1.02	1.33						
Departures		+.03	0	0	+.09						
MADISON, WIS.											
Jan. 5	0.74	.88	1.02	1.22		1.68		1.21			.96
Jan. 12	2.16			1.24							2.06
Jan. 17	.74		1.04			1.49					.81
Jan. 18	.23		.95	1.19		1.73		1.07			.46
Jan. 20	1.07	.84									1.52
Jan. 25	.53	.95	1.01	1.25		1.69		1.14			.91
Jan. 27	.86		1.06	1.19		1.60					1.32
Means		.89	1.02	1.22		1.64		1.14			
Departures		−.06	−.03	+.02		+.02		−.01			
LINCOLN, NEBR.											
Jan. 2	0.43		.78	1.11	1.50			1.32			1.12
Jan. 4	1.37	1.17	1.27	1.30					1.26	1.11	.79
Jan. 11	1.68								1.16		4.47
Jan. 16	2.06							1.03	.95	.83	1.88
Jan. 18	.25	1.17	1.26	1.37	1.54						.36
Jan. 19	.79	1.08	1.21	1.35	1.46						.87
Jan. 20	.56	1.02	1.22	1.36	1.51						1.10
Jan. 22	.43	.81	.86	1.04				1.17	1.05	.90	.86
Jan. 25	.36	1.09	1.22	1.35	1.51						.48
Jan. 26	.51	.96	1.13	1.34	1.54			1.38	1.23	1.13	.79
Jan. 27	.28	.74	1.16	1.10							.91
Jan. 29	1.32			1.31				1.30	1.20	1.07	2.02
Means		1.00	1.12	1.27	1.51			1.24	1.14	1.01	
Departures		+.07	+.07	+.07	+.11			+.05	+.09	+.08	

*Extrapolated.

TABLE 2.—*Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface*

[Gram-calories per square centimeter]

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Fairbanks	Twin Falls	La Jolla	Miami	New Orleans	Riverside	Blue Hill	Newport	Friday Harbor	Cambridge	Albuquerque
	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
Jan. 1	188	168	180	115	137	136	7	106	149	304	152	125	216	213	75	190	242
Jan. 8	125	91	164	54	57	159	14	103	206	305	240	176	136	138	90	109	294
Jan. 15	190	220	234	174	170	85	28	168	311	295	284	200	182	181	81	162	270
Jan. 22	245	214	286	179	191	122	13	128	246	387	244	229	227	227	74	200	370
DEPARTURES FROM WEEKLY NORMALS																	
Jan. 1	+19	+40	+5	+31	+31	−12	0	−46	−81	+5	−20	−136	+71	+65	+5		
Jan. 8	−24	−40	−18	−25	−48	−4	+4	−52	−51	+7	+34	−79	−17	+26	+13		
Jan. 15	+33	+66	+38	+75	+55	−96	+14	−4	+45	+8	+64	−20	+13	−8	+1		
Jan. 22	+66	+29	+54	+58	+38	+9	−13	−54	−48	+52	+41	−49	+31	+31	−5		
ACCUMULATED DEPARTURES ON JANUARY 28																	
	+658	+665	+553	+973	+532	−721	+35	−1,092	−945	+504	+833	−1,988	+686	−434	+96		

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy (Ret.) Superintendent, U. S. Naval Observatory. Data from measurements at the U. S. Naval Observatory from plates obtained at the observatories indicated. Difference in longitude is measured from the central meridian, positive toward the west. Latitude is positive toward the north. Areas are corrected for foreshortening and expressed in millionths of Sun's hemisphere. For each day below longitude, latitude, area of spot or groups, and spot count, are given respectively the assumed longitude of the center of the disk, assumed latitude of the center of the disk, total area of spots and groups, and total spot count]

Date	Eastern standard time		Mount Wilson group No.	Heliographic: Difference in longitude	Heliographic: Longitude	Heliographic: Latitude	Heliographic: Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory
1940	h	m		°	°	°	°				
Jan. 1	11	44	6725	−52	118	+11	53	73	4	G	U. S. Naval.
			6723	−41	129	+17	44	145	2		
			6716	+76	246	−12	76	145	5		
					(170)	(−3)		363	11		
Jan. 2	10	54	6725	−39	119	+11	40	194	8	G	Do.
			6723	−27	131	+17	34	73	2		
			6724	−26	132	+9	27	61	2		
			6726	−11	147	−7	12	12	2		
					(158)	(−3)		340	14		
Jan. 3	11	10	6725	−25	119	+11	27	485	35	G	Do.
			6723	−15	129	+18	25	73	3		
			6724	−12	132	+9	17	97	11		
			6726	+4	148	−5	7	24	2		
					(144)	(−3)		679	51		
Jan. 4	10	52	6727	−60	71	+19	61	24	1	P	Do.
			6725	−12	119	+11	17	1357	40		
			6723	−2	129	+19	21	121	11		
			6724	+1	132	+10	12	97	10		
					(131)	(−3)		1599	62		
Jan. 5	11	43	6727	−46	72	+19	50	24	1	G	Do.
			6725	+4	122	+11	14	2279	40		
			6723	+11	129	+18	23	97	7		
			6724	+17	135	+10	21	97	5		
					(118)	(−3)		2497	53		
Jan. 6	10	50	6725	+17	122	+11	21	2327	38	G	Do.
			6723	+24	129	+18	31	73	3		
			6724	+28	133	+10	30	97	5		
					(105)	(−4)		2497	46		
Jan. 9	10	47	6728	−5	60	−8	8	73	9	VG	Do.
			(*)	+20	85	+21	31	109	8		
			(*)	+30	95	+19	37	12	1		
			6725	+58	123	+11	60	2230	30		
					(65)	(−4)		2424	48		
Jan. 10	11	34	6728	+9	61	−8	10	48	12	VG	Do.
			(*)	+33	85	+21	41	48	3		
			6725	+71	123	+11	73	1988	15		
					(52)	(−4)		2084	30		
Jan. 12	12	28	6730	−52	333	−10	53	97	6	F	Mt. Wilson.
			6729	−26	359	+15	32	24	3		
			6728	+38	63	−8	39	73	10		
					(25)	(−4)		194	19		
Jan. 13	11	41	6730	−40	332	−10	41	145	22	G	Do.
			6733	−31	341	−12	32	12	3		
			6732	+21	33	−17	24	12	2		
			6731	+28	40	+8	31	18	2		
			6728	+51	63	−8	51	121	16		
					(12)	(−4)		308	45		
Jan. 14	11	27	6730	−27	332	−10	28	242	21	G	Do.
			6733	−18	341	−13	20	73	7		
			6732	+36	35	−18	39	6	1		
			6731	+40	39	+8	42	6	1		
			6728	+64	63	−8	64	170	23		
					(359)	(−5)		497	53		
Jan. 15	11	32	(*)	−70	276	+26	75	24	2	F	U. S. Naval.
			6734	−60	286	−19	61	48	9		
			6730	−13	333	−9	14	242	32		
			6733	−5	341	−13	10	48	7		
			6728	+78	64	−8	78	121	12		
					(346)	(−5)		483	62		

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time		Mount Wilson group No.	Heliographic: Difference in longitude	Heliographic: Longitude	Heliographic: Latitude	Heliographic: Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory
1940	h	m		°	°	°	°				
Jan. 16	13	31	6735	−79	253	−17	79	12	1	VG	U. S. Naval.
			6736	−78	254	−11	78	12	1		
			(*)	−60	272	−7	60	24	8		
			6734	−46	286	−19	48	97	14		
			6730	0	332	−9	4	201	44		
			6733	+9	341	−13	12	48	11		
					(332)	(−5)		484	74		
Jan. 17	13	10	6736	−65	254	−11	65	24	1	G	Do.
			6735	−62	257	−15	63	24	2		
			6734	−32	287	−19	35	242	10		
			6737	−1	318	−11	6	48	4		
			6730	+12	331	−10	13	376	20		
			6733	+22	341	−12	23	12	4		
					(319)	(−5)		726	41		
Jan. 18	18	39	6736	−49	254	−12	50	24	1	P	Mt. Wilson.
			6735	−44	259	−15	45	24	2		
			6734	−17	286	−20	23	242	20		
			6737	+17	320	−12	19	12	2		
			6730	+27	330	−10	28	339	14		
					(303)	(−5)		641	39		
Jan. 19	11	16	(*)	−42	252	−18	44	12	4	G	Do.
			6736	−38	256	−12	39	24	2		
			6735	−34	260	−15	30	24	3		
			6734	−18	276	−20	24	194	28		
			6738	−9	285	+14	21	97	11		
			6730	+40	334	−10	41	242	25		
					(294)	(−5)		593	73		
Jan. 20	11	15	6740	−77	203	−6	77	24	1	VG	U. S. Naval.
			6736	−25	255	−11	26	6	3		
			6735	−22	258	−15	25	48	10		
			6739	−12	268	−11	14	121	9		
			6738	+4	284	+14	19	73	9		
			6734	+5	285	−19	16	145	17		
			6730	+50	330	−10	50	73	4		
					(280)	(−5)		490	53		
Jan. 21	12	6	6740	−63	204	−5	63	12	2	F	Do.
			6735	−11	256	−15	15	48	3		
			6739	+2	269	−10	6	145	9		
			6738	+17	284	+14	25	97	6		
			6734	+17	284	−19	22	145	12		
					(267)	(−5)		447	32		
Jan. 22	11	22	6740	−51	203	−5	51	48	7	G	Do.
			6735	+2	256	−15	11	24	1		
			6735	+9	263	−14	13	73	9		
			6739	+11	265	−9	12	73	10		
			6739	+18	272	−9	19	73	2		
			6734	+28	282	−19	31	24	1		
					(254)	(−5)		315	30		
Jan. 24	12	24	6740	−20	207	−5	20	48	7	VG	Do.
			6735	+28	255	−14	29	12	8		
			6735	+30	257	−15	32	242	16		
			6739	+44	271	−9	44	133	5		
					(227)	(−5)		435	36		
Jan. 25	10	56	6740	−13	202	−7	13	24	2	F	Do.
			6740	−6	209	−7	6	24	2		
			6735	+48	263	−14	49	194	6		
			6739	+58	273	−10	58	97	1		
					(215)	(−5)		339	11		
Jan. 26	11	6	6741	−74	127	+12	76	679	7	G	Do.
			6740	+6	207	−7	6	97	11		
			6735	+63	264	−14	64	242	4		
			6739	+70	271	−10	70	48	1		
					(201)	(−6)		1066	23		
Jan. 27	10	41	6741	−78	111	+12	80	630	7	VG	Do.
			6741	−61	128	+11	63	776	16		
			6740	+19	208	−7	19	73	11		
			6735	+76	265	−14	76	242	9		
			6739	+84	273	−11	84	48	1		
					(189)	(−6)		1769	44		

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Mount Wilson group No.	Heliographic: Difference in longitude	Heliographic: Longitude	Heliographic: Latitude	Heliographic: Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory
1940	h m		°	°	°	°				
Jan. 28	11 10	6741	−64	111	+12	66	630	10	G	U. S. Naval.
		6741	−47	128	+11	50	776	12		
		6740	+33	208	−7	33	97	10		
				(175)	(−6)		1503	32		
Jan. 29	11 14	6741	−49	113	+12	52	630	10	G	Do.
		6741	−32	130	+11	36	776	17		
		6740	+47	209	−7	47	97	10		
				(162)	(−6)		1503	37		
Jan. 30	14 50	6742	−76	71	+7	76	388	2	P	Do.
		6743	−75	72	−24	76	97	1		
		6741	−34	113	+12	38	533	6		
		6741	−18	129	+11	25	679	7		
		6740	+61	208	−7	61	48	1		
				(147)	(−6)		1745	17		
Jan. 31	13 10	(*)	−73	62	−8	73	12	1	VG	Do.
		6743	−68	67	−23	68	12	1		
		6742	−62	73	−7	62	242	2		
		6743	−61	74	−24	63	121	1		
		6741	−21	114	+12	27	533	15		
		6741	−5	130	+11	17	679	8		
				(135)	(−6)		1599	28		

Mean daily area for 27 days=1023.

*=not numbered VG=very good; G=good; F=fair; P=poor.

PROVISIONAL SUNSPOT RELATIVE NUMBERS FOR JANUARY 1940

[Dependent alone on observations at Zurich]

[Data furnished through the courtesy of Prof. W. Brunner, Eidgen. Sternwarte, Zurich, Switzerland]

January 1940	Relative numbers	January 1940	Relative numbers	January 1940	Relative numbers
1	*Ec* 39	11	*Ec* 50	21	*a* 71
2	37	12	29	22	* 75
3	42	13	34	23	52
4	--	14	61	24	34
5	*b* --	15	**Ec* 33	25	*d* --
6	* 55	16	*a* 61	26	* 54
7	--	17	--	27	
8	38	18	64	28	
9	*Mc* --	19	59	29	
10	41	20	*Mac* 88	30	

Mean, 20 days =50.9.

* Observed at Chur.
a=Passage of an average-sized group through the central meridian.
b=Passage of a large group through the central meridian.
c=New formation of a group developing into a middle-sized or large center of activity: E, on the eastern part of the sun's disk; W, on the western part; M, in the central-circle zone.
d=Entrance of a large or average-sized center of activity on the east limb.

AEROLOGICAL OBSERVATIONS

[Aerological Division, D. M. LITTLE, in charge]

By B. FRANCIS DASHIELL

The lowest mean free-air pressures for January prevailed over northeastern Canada (Newfoundland Airport, 48°58′ N., 54°35′ W.), Sault Ste. Marie, Mich., and Fairbanks, Alaska, at all levels (charts VIII, IX, X, and XI). Highest mean pressure occurred in the South, being centered over Miami, Fla. However, at 5,000 feet (chart VIII), pressure was slightly highest over the Rocky Mountain region (southern Colorado). During the current month the Alaskan mean pressures were higher than those recorded in any preceding month. Also, the Fairbanks, Alaska, pressures, which heretofore have been lower than those observed at Sault Ste. Marie, Mich., were higher during January.

The pressure gradient between the regions of high and low pressures (Miami, Fla., and Sault Ste. Marie, Mich., respectively) increased steadily with altitude up to 8 kilometers, and then slowly diminished. This gradient showed a mean difference of 9, 18, 27, 35, 39, 35, 29, and 20 millibars at 0.5, 1.5, 3, 5, 8, 10, 12, and 14 kilometers, respectively.

The persistence of outstanding low-surface temperatures during January was reflected by the minimum mean free-air temperatures (° C.) recorded by radiosondes and airplanes. Lowest mean temperatures occurred over Sault Ste. Marie, Mich., in all levels up to 9 kilometers; then over Bismarck, N. Dak., at 10 kilometers; Boise, Idaho, and Oklahoma City, Okla., at 11 kilometers; Medford, Oreg., at 12 kilometers; and Miami, Fla., at 14, 15, 16, 17, 18, and 19 kilometers. A low mean temperature of −74.2° C. was noted over Miami, Fla., at 17 kilometers. Highest mean temperatures occurred also over Miami, Fla., in all lower levels up to 11 kilometers; then over Joliet, Ill., at 12, 13, 14, and 15 kilometers; and over Nashville, Tenn., at 16 and 17 kilometers. Alaskan mean temperatures were warmer than those recorded at several stations within the United States proper. Up to 9 kilometers, Sault Ste. Marie., Mich., averaged about 4° C. colder than Fairbanks, Alaska, at all levels.

Mean temperatures were colder than those occurring in all previous months of record, even at those stations with 18 months of radiosonde observations. This condition persisted up to 11 kilometers, but above that level January was generally warmer than most previous months. Comparing January with the corresponding month of 1939 at those stations having a complete year of radiosonde observations, it was found that the current month was colder over all portions of the country except the western slope of the Rockies. The greatest tendency toward lower 1940 temperatures occurred over the northern and eastern portions of the United States during January.

Individual minimum temperatures were lowest over the far South and West, with the extremes occurring at Miami, Fla. (−78.0° C.), El Paso, Texas (−76.1° C.), Phoenix, Ariz. (−75.0° C.), San Diego, Calif. (−72.0° C.), and Medford, Oreg. (−72.0° C.). However, these individual temperatures were generally warmer than extreme minimum temperatures recorded during previous months at altitudes ranging from 16 to 18 kilometers.

The levels of mean freezing temperatures (0° C.) in the free air ranged from a surface line reaching from North Carolina, Alabama, Oklahoma, Arizona, Nevada, and Washington, to altitudes of 3,710 meters over Miami,

Fla.; 2,950 meters over San Antonio, Texas; 2,100 meters over Albuquerque, N. Mex.; 2,940 meters over Phoenix, Ariz.; and 2,190 meters over Medford, Oreg.

Resultant-wind directions were predominantly northwesterly over the northern and eastern portions of the country, except in Florida. This flow of air, appearing during a month of abnormal cold, showed directions to be decidedly more northerly than in the same month of 1939. A similar situation existed at 5 and 10 kilometers (charts X and XI), and intermediate levels as shown in table 2, where the observations are based on 5 p. m. observations.

The resultant velocities were high in the East at 1.5 kilometers (chart VIII), and in the Southwest at 3 and 5 kilometers (charts IX and X, respectively). Outstanding resultant velocities of 31.0, 47.8, and 51.7 meters per second, at 5, 8, and 10 kilometers, respectively, occurred over Greensboro, N. C. Except for the South, the current velocities were generally lower than in January 1939.

Also, diurnal variations in direction at 1.5 and 3 kilometers (charts VIII and IX, and table 2) indicated that the 5 p. m. winds were more northerly than the early morning winds over all of the country except the far West at 1.5 kilometers, and over all but the south-central portion at 3 kilometers. Afternoon velocities were higher than at 5 a. m. in the extreme North and South at both levels.

At 1.5 and 3 kilometers the January 5 a. m. wind directions departed from the established normals at a number of well-located stations by clockwise rotations over the entire United States, with the exception of the far Northwest, where current departures backed away from normal in counterclockwise rotations. The wind velocities were greater than normal in all sections except the Northeast at 1.5 kilometers, and less than normal everywhere but the far South, at 3 kilometers.

Table 3 shows individual maximum wind velocities for January. These were not particularly outstanding, although somewhat greater than usual. The velocity of 86 meters per second recorded over Atlanta, Ga., at 9,990 meters, was the greatest to occur in the Southeast in the upper air, and has been exceeded but four times elsewhere during the past several years.

MEAN MONTHLY ISENTROPIC CHART [1]

In the mean isentropic chart, $\theta=296°$, for January 1940 (chart XII), strong west and northwest winds extend over most of the United States with no indication of an anticyclonic eddy. Judging from the light easterly wind at Merida, Yucatan, a weak anticyclonic eddy probably exists over the southern portion of the Gulf of Mexico; and in the Far West there exists a distinct anticyclonic ridge as shown both by winds and moisture.

Precipitation amounts were mostly subnormal over the central and eastern parts of the country, probably a consequence of the almost continuous regime of polar air over these regions and the blocking of moisture transport from the Gulf of Mexico. The interesting contrast on the west coast of precipitation deficit in the North Pacific States and excess in California apparently cannot be explained by the pattern shown on the chart.

[1] Prepared by Division of Research and Education.

TABLE 1.—*Mean free-air barometric pressure (P.) in millibars, temperature in °C., and relative humidities (R. H.) in percent, obtained by airplanes and radiosondes during January 1940*

Stations and elevations in meters above sea level

Altitude (meters) m. s. l.	Albuquerque, N. Mex. (1,620 m.)				Atlanta, Ga. (300 m.)				Billings, Mont. (1,089 m.)				Bismarck, N. Dak. (505 m.)				Boise, Idaho (824 m.)				Buffalo, N. Y. (220 m.)				Charleston, S. C. (14 m.)			
	Number of observations	P.	T.	R. H.	Number of observations	P.	T.	R. H.	Number of observations	P.	T.	R. H.	Number of observations	P.	T.	R. H.	Number of observations	P.	T.	R. H.	Number of observations	P.	T.	R. H.	Number of observations	P.	T.	R. H.
Surface	31	838	0.8	62	31	985	−3.1	73	31	894	−10.1	84	31	962	−18.7	88	31	919	−0.2	87	29	989	−8.5	85	31	1,018	0.4	78
500					31	960	−3.3	72													29	954	−9.3	80	31	959	2.1	65
1,000					31	902	−2.0	69					31	901	−13.0	85	31	904	0.1	85	29	894	−12.0	83	31	901	0.6	62
1,500					31	847	−1.9	59	31	848	−5.7	80	31	844	−11.2	82	31	850	−1.1	81	29	837	−13.8	81	31	846	−0.4	57
2,000	31	800	0.5	59	31	795	−3.2	56	31	795	−6.8	77	31	790	−11.4	80	31	798	−2.9	81	29	783	−15.7	79	31	795	−1.5	51
2,500	31	751	−2.0	60	31	746	−4.9	56	31	746	−8.9	76	31	741	−12.9	77	31	749	−5.0	80	29	733	−17.1	75	31	747	−3.3	49
3,000	31	705	−4.4	60	31	700	−6.8	57	31	699	−11.8	78	31	693	−15.3	77	31	702	−7.5	79	29	685	−18.9	71	31	701	−5.5	48
4,000	31	620	−9.2	55	31	615	−11.3	53	31	612	−17.1	75	31	606	−20.8	76	31	617	−13.2	72	29	598	−24.4	68	31	616	−10.2	46
5,000	31	545	−15.4	49	31	539	−17.0	50	31	535	−23.2	74	31	529	−27.4	75	30	540	−19.6	68	29	521	−30.7	67	31	540	−16.1	44
6,000	31	476	−22.4	43	30	471	−23.6	48	30	466	−30.0	73	31	460	−34.1	75	30	472	−26.7	66	29	452	−37.5	65	31	472	−22.4	44
7,000	31	415	−29.7	39	30	410	−31.0	47	30	404	−37.0	69	31	398	−41.2	76	29	410	−34.3	63	29	390	−43.9	64	30	412	−29.4	43
8,000	31	359	−38.1	39	30	355	−38.7	46	29	349	−44.3		28	342	−48.4		28	354	−41.5	63	29	335	−49.1		30	357	−36.9	41
9,000	30	310	−45.9		29	306	−46.5		29	300	−51.3		24	293	−54.7		28	305	−49.2		28	288	−52.7		29	308	−44.3	
10,000	29	266	−53.0		29	263	−52.1		29	256	−57.1		22	250	−59.0		26	261	−56.2		26	246	−54.3		28	264	−50.2	
11,000	26	227	−58.7		29	225	−56.0		27	219	−59.3		19	213	−58.7		24	223	−60.2		25	211	−54.4		25	227	−54.5	
12,000	26	194	−58.9		29	192	−57.4		27	186	−58.3		17	182	−56.8		23	190	−60.1		24	180	−54.1		23	194	−56.5	
13,000	24	165	−58.9		27	164	−58.8		27	159	−57.6		9	155	−55.9		18	162	−59.1		21	154	−54.6		18	165	−58.9	
14,000	24	141	−60.7		26	140	−60.8		24	136	−58.0		9	132	−55.9		17	138	−59.2		17	131	−55.3		15	140	−61.5	
15,000	23	120	−63.4		23	119	−63.1		17	115	−58.9						12	118	−61.3		12	112	−56.3		10	118	−63.9	
16,000	16	102	−65.6		20	101	−64.3		15	98	−59.6						9	100	−62.6						9	100	−64.9	
17,000	9	86	−66.7		11	86	−64.3		6	83	−60.0						6	85	−63.0									
18,000					5	73	−63.0																					

TABLE 1.—*Mean free-air barometric pressure (P.) in millibars, temperature in °C., and relative humidities (R. H.) in percent, obtained by airplanes and radiosondes during January 1940*—Continued

Stations and elevations in meters above sea level

Altitude (meters) m. s. l.	Dayton, Ohio[1] (150 m.)				Denver, Colo. (1,616 m.)				El Paso, Tex. (1,193 m.)				Ely, Nev. (1,908 m.)				Fairbanks, Alaska (153 m.)				Joliet, Ill. (178 m.)				Juneau, Alaska (49 m.)			
	Number of observations	P.	T.	R. H.	Number of observations	P.	T.	R. H.	Number of observations	P.	T.	R. H.	Number of observations	P.	T.	R. H.	Number of observations	P.	T.	R. H.	Number of observations	P.	T.	R. H.	Number of observations	P.	T.	R. H.
Surface	22	990	−9.0	77	31	837	−8.1	78	31	884	2.4	65	31	810	−5.3	88	30	993	−15.8	72	31	998	−11.3	87	31	1,008	0.5	73
500	22	958	−10.2	82													30	950	−11.4	74	31	956	−11.9	88	31	953	−1.3	72
1,000	22	897	−11.9	84													30	890	−10.2	72	31	896	−11.7	85	31	895	−3.3	73
1,500	22	841	−12.4	78					31	852	5.3	59					30	834	−9.2	71	31	839	−10.8	78	31	839	−5.0	75
2,000	22	788	−13.2	77	31	797	−3.7	72	31	801	3.6	54	31	800	−3.6	83	30	782	−10.4	72	31	786	−12.0	75	30	787	−6.8	78
2,500	21	737	−14.2	78	31	748	−5.5	67	31	753	1.8	52	31	752	−3.1	76	30	732	−12.9	69	31	736	−13.7	72	30	738	−8.8	80
3,000	19	690	−15.6	76	31	702	−7.4	66	31	707	−0.9	52	31	705	−5.4	74	30	685	−15.9	68	31	689	−15.8	69	30	692	−11.2	81
4,000	16	603	−20.5	75	31	616	−13.0	68	31	623	−6.9	45	31	620	−10.8	68	30	599	−22.3	68	31	603	−21.3	65	28	607	−16.5	76
5,000	12	526	−26.5	76	31	540	−18.7	69	31	548	−13.2	42	31	544	−17.3	65	30	522	−28.9	66	31	526	−27.3	63	28	530	−23.3	75
6,000	9	457	−33.0	77	31	471	−25.7	67	31	480	−19.9	39	31	475	−24.1	62	29	453	−36.2	64	28	457	−34.1	60	26	462	−30.6	74
7,000					30	409	−33.0	65	31	418	−27.3	38	31	412	−31.7	59	28	391	−43.1	63	28	395	−41.2	56	22	400	−37.9	72
8,000					30	355	−40.8	65	31	363	−35.0	37	31	358	−39.4	58	27	337	−49.8		27	341	−47.2		20	345	−45.3	
9,000					30	305	−46.8		31	314	−43.1		30	309	−47.2		27	288	−55.6		24	292	−52.3		18	296	−52.4	
10,000					28	262	−54.8		31	270	−50.6		29	265	−54.1		27	246	−58.7		22	250	−54.8		17	253	−58.0	
11,000					27	224	−58.6		29	231	−56.8		29	227	−59.5		25	210	−58.3		16	214	−54.8		12	216	−57.9	
12,000					25	191	−58.6		29	197	−59.4		29	193	−59.4		21	179	−57.1		15	182	−53.9		10	184	−55.6	
13,000					23	163	−57.6		27	168	−60.5		28	164	−58.2		17	152	−56.6		13	156	−53.6		10	158	−55.2	
14,000					18	139	−57.4		25	143	−62.8		28	140	−59.3		15	130	−56.7		11	133	−54.3		8	135	−55.7	
15,000					14	119	−59.1		23	121	−65.9		26	119	−61.6		10	111	−57.3		7	114	−55.5		7	115	−56.4	
16,000					9	101	−60.4		20	103	−68.2		24	102	−63.1		8	94	−58.4						5	98	−57.3	
17,000					5	86	−61.6		13	87	−69.4		16	87	−63.8		8	79	−58.4									
18,000													8	73	−62.0		5	68	−58.4									

Stations and elevations in meters above sea level

Altitude (meters) m. s. l.	Lakehurst, N. J.[3] (39 m.)				Medford, Oreg. (401 m.)				Miami, Fla. (4 m.)				Minneapolis, Minn. (263 m.)				Nashville, Tenn. (180 m.)				Norfolk, Va.[3] (10 m.)				Oakland, Calif. (2 m.)			
	Number of observations	P.	T.	R. H.	Number of observations	P.	T.	R. H.	Number of observations	P.	T.	R. H.	Number of observations	P.	T.	R. H.	Number of observations	P.	T.	R. H.	Number of observations	P.	T.	R. H.	Number of observations	P.	T.	R. H.
Surface	29	1,012	−7.6	73	28	968	4.6	86	31	1,019	12.3	88	31	989	−14.6	84	31	1,000	−5.3	77	19	1,020	−3.7	64	31	1,017	9.8	82
500	29	953	−8.1	73	28	957	4.8	81	31	961	13.5	74	31	958	−14.0	85	31	960	−5.9	80	19	958	−5.7	60	31	958	9.9	78
1,000	29	894	−9.8	72	28	900	5.7	64	31	905	11.3	70	31	898	−12.6	79	31	900	−7.0	80	19	898	−7.0	57	31	902	8.5	71
1,500	29	837	−10.9	74	28	847	4.1	58	31	853	9.5	60	31	841	−12.6	75	31	845	−6.7	76	19	842	−7.5	52	31	850	5.9	67
2,000	29	785	−11.9	72	28	796	1.1	56	31	803	8.0	53	31	787	−13.3	70	31	792	−7.1	74	19	790	−8.9	49	31	799	3.7	60
2,500	29	735	−13.6	70	28	748	−1.9	54	31	755	6.5	46	31	737	−14.8	68	31	743	−8.3	70	19	741	−10.2	47	31	751	0.9	58
3,000	29	688	−15.4	68	28	702	−4.8	55	31	710	3.8	45	31	690	−17.3	67	30	696	−10.3	65	19	694	−12.2	47	31	705	−2.0	55
4,000	29	602	−20.4	60	27	617	−11.0	53	31	628	−1.6	43	31	602	−22.7	64	29	611	−14.6	62	19	606	−17.4	47	31	621	−8.1	50
5,000	25	524	−26.7	60	27	541	−17.4	51	31	553	−7.0	40	31	525	−29.1	61	29	534	−20.0	58	13	532	−23.9	48	31	545	−14.5	50
6,000	25	456	−33.3	63	27	473	−25.0	50	30	485	−13.5	37	31	456	−35.9	59	29	466	−26.7	55					31	477	−21.4	48
7,000	25	395	−39.7	69	26	411	−32.0	50	30	425	−20.4	36	29	394	−43.1	59	28	405	−33.0	51					31	416	−28.5	47
8,000	25	341	−45.2		26	356	−39.8		30	371	−27.2	36	28	330	−48.9		28	350	−39.8	50					31	361	−36.5	47
9,000	24	294	−50.0		24	306	−47.4		30	322	−34.6	35	27	290	−53.6		27	302	−46.5						31	311	−36.5	
10,000	23	252	−53.3		23	262	−53.9		30	278	−42.2		26	248	−56.3		25	259	−51.9						31	268	−44.6	
11,000	22	216	−55.1		21	224	−59.0		30	240	−49.2		25	212	−56.3		19	222	−54.3						30	229	−52.2	
12,000	20	184	−55.0		20	191	−61.4		30	205	−55.3		24	181	−55.5		18	190	−54.5						30	195	−57.9	
13,000	18	158	−55.7		19	163	−60.4		29	175	−60.7		22	155	−55.3		17	163	−55.0						30	166	−59.8	
14,000	17	135	−56.1		16	139	−60.2		28	149	−65.0		19	132	−55.8		15	139	−55.8						29	142	−59.7	
15,000	17	115	−56.6		13	118	−61.4		27	126	−68.7		13	113	−56.5		10	118	−56.4						27	120	−60.2	
16,000	9	98	−58.9		10	101	−62.4		26	106	−71.9						8	101	−56.6						26	102	−61.7	
17,000	8	83	−59.5		7	86	−62.3		24	90	−74.2						5	86	−56.3						20	87	−63.5	
18,000									21	76	−74.1														11	74	−64.5	
19,000									8	63	−71.0														5	62	−64.1	

See footnotes at end of table.

TABLE 1.—*Mean free-air barometric pressure (P.) in millibars, temperature in °C., and relative humidities (R. H.) in percent, obtained by airplanes and radiosondes during January 1940*—Continued

Stations and elevations in meters above sea level

Altitude (meters) m. s. l.	Oklahoma City, Okla. (391 m.) Number of observations	P.	T.	R. H.	Omaha, Nebr. (301 m.) Number of observations	P.	T.	R. H.	Pearl Harbor, T. H.[2] (6 m.) Number of observations	P.	T.	R. H.
Surface	30	978	−6.0	80	31	988	−14.9	81	31	1,011	19.3	89
500	30	963	−5.9	79	31	962	−13.5	81	31	955	19.1	74
1,000	30	904	−4.7	70	31	901	−10.6	74	31	901	15.1	79
1,500	30	849	−3.6	62	31	845	−8.5	66	31	850	13.4	66
2,000	30	796	−3.6	60	31	791	−9.3	62	31	800	11.4	53
2,500	30	747	−5.0	58	31	742	−11.2	61	31	754	9.9	38
3,000	30	701	−6.9	56	31	695	−13.6	60	31	710	7.3	29
4,000	28	616	−11.8	51	31	608	−18.5	60	31	627	1.4	24
5,000	28	540	−17.4	48	31	532	−24.5	59				
6,000	28	472	−24.7	50	29	462	−30.8	58				
7,000	28	410	−32.1	49	28	401	−38.0	57				
8,000	28	356	−39.9	49	28	346	−45.2					
9,000	25	306	−47.8		28	297	−51.7					
10,000	20	262	−55.4		27	254	−56.9					
11,000	18	224	−60.2		26	217	−58.4					
12,000	16	190	−60.6		26	184	−57.7					
13,000	12	162	−60.0		23	157	−57.1					
14,000	8	137	−60.7		20	134	−57.7					
15,000					14	114	−58.5					
16,000					9	97	−59.2					
17,000												
18,000												

Altitude (meters) m. s. l.	Pensacola, Fla.[2] (24 m.) Number of observations	P.	T.	R. H.	Phoenix, Ariz. (339 m.) Number of observations	P.	T.	R. H.
Surface	28	1,021	3.1	70	31	977	9.3	56
500	28	962	2.8	61	31	959	13.1	57
1,000	28	905	3.6	49	31	903	11.8	55
1,500	28	851	3.1	44	31	850	8.6	54
2,000	28	800	2.1	42	31	800	5.4	56
2,500	28	751	0.7	38	31	753	2.6	55
3,000	28	705	−1.3	37	31	707	−0.3	54
4,000	28	622	−5.8	31	31	624	−6.3	49
5,000	28	547	−11.4	31	31	548	−12.9	45
6,000	23	479	−17.8	34	31	480	−20.2	43
7,000	23	419	−24.9	35	30	418	−27.8	42
8,000	20	364	−32.3	37	30	363	−35.5	41
9,000	20	315	−39.4	37	30	313	−43.5	39
10,000	16	272	−46.4		29	270	−51.0	
11,000	13	233	−52.0		29	231	−57.2	
12,000	11	199	−55.0		26	197	−58.3	
13,000	8	170	−57.9		25	168	−59.0	
14,000	6	144	−60.6		23	143	−61.0	
15,000					18	122	−63.6	
16,000					11	103	−65.9	
17,000					7	88	−67.5	
18,000					5	74	−65.6	

Altitude (meters) m. s. l.	St. Louis, Mo. (171 m.) Number of observations	P.	T.	R. H.	San Antonio, Tex. (174 m.) Number of observations	P.	T.	R. H.
Surface	31	1,002	−10.2	83	31	1,003	4.0	71
500	31	960	−11.8	85	31	964	5.4	67
1,000	31	899	−10.8	84	31	906	4.2	61
1,500	31	843	−9.6	79	31	852	3.7	58
2,000	31	790	−9.9	74	31	801	3.2	57
2,500	31	740	−11.6	70	31	753	2.0	55
3,000	31	693	−13.9	67	31	707	−0.2	51
4,000	31	607	−18.8	64	31	624	−5.3	48
5,000	31	530	−24.8	61	31	549	−11.6	46
6,000	30	461	−31.7	59	28	481	−18.6	46
7,000	30	399	−38.9	57	28	420	−26.1	44
8,000	30	344	−45.6		28	365	−33.6	44
9,000	29	296	−51.6		28	315	−41.3	
10,000	29	253	−55.7		27	271	−48.8	
11,000	27	216	−56.6		25	232	−54.9	
12,000	27	184	−55.6		24	198	−58.0	
13,000	26	157	−56.3		24	169	−60.7	
14,000	22	134	−57.1		24	144	−62.7	
15,000	13	114	−58.3		21	122	−65.4	
16,000	8	97	−58.5		16	103	−67.5	
17,000					8	88	−67.8	
18,000								

Stations and elevations in meters above sea level

Altitude (meters) m. s. l.	San Diego, Calif.[2] [4] (10 m.) Number of observations	P.	T.	R. H.	Sault Ste. Marie, Mich. (221 m.) Number of observations	P.	T.	R. H.	Seattle, Wash.[2] (10 m.) Number of observations	P.	T.	R. H.
Surface	29	1,016	13.4	83	31	987	−11.5	92	26	1,015	5.1	75
500	29	959	13.0	71	31	952	−11.7	95	26	958	5.5	60
1,000	29	903	11.4	59	31	892	−13.7	96	26	901	3.3	60
1,500	29	850	9.2	51	31	835	−15.4	94	24	847	1.3	62
2,000	29	801	6.9	42	31	781	−17.0	91	22	796	−1.1	62
2,500	29	753	4.5	36	31	731	−18.3	88	21	747	−3.5	61
3,000	29	708	1.6	37	31	683	−20.4	85	18	701	−5.9	61
4,000	28	624	−5.1	43	31	596	−25.9	82	10	617	−12.2	63
5,000	15	549	−11.9	49	31	518	−32.5	80	5	540	−19.1	65
6,000	14	480	−18.3	54	31	449	−39.4	77				
7,000	14	419	−25.1	54	29	387	−46.9					
8,000	14	365	−32.7	55	29	332	−52.4					
9,000	14	317	−40.2		25	284	−56.7					
10,000	13	274	−46.6		22	243	−57.8					
11,000	12	235	−51.7		21	207	−56.7					
12,000	12	201	−54.3		13	176	−55.3					
13,000	11	173	−56.1		8	151	−55.1					
14,000	9	148	−57.8		6	129	−55.5					
15,000	7	126	−59.4									
16,000	7	107	−62.5									
17,000												

Altitude (meters) m. s. l.	Shreveport, La.[3] (51 m.) Number of observations	P.	T.	R. H.	Spokane, Wash. (598m.) Number of observations	P.	T.	R. H.	Washington, D. C.[2] (7 m.) Number of observations	P.	T.	R. H.
Surface	25	1,017	0.4	78	31	950	−1.9	81	27	1,020	−6.3	71
500	25	962	0.0	75					27	958	−7.4	68
1,000	25	905	−0.1	72	31	902	−2.2	78	27	898	−8.9	72
1,500	25	851	−0.7	70	31	847	−3.5	76	26	842	−9.9	72
2,000	25	799	−1.7	68	31	795	−5.6	77	26	789	−10.2	65
2,500	25	749	−3.0	64	31	746	−7.3	75	26	739	−11.6	59
3,000	24	703	−4.6	63	31	699	−9.5	73	26	692	−13.6	60
4,000	23	619	−9.1	61	31	613	−15.2	71	26	605	−18.8	60
5,000	20	542	−14.3	56	31	537	−21.4	69	26	529	−24.9	60
6,000	15	472	−19.5	53	30	468	−28.4	69	26	461	−31.2	59
7,000	10	414	−26.7	51	30	406	−35.7	68	26	399	−38.0	64
8,000	5	358	−34.9		30	351	−43.1	64	24	344	−44.8	
9,000					30	301	−50.1		24	295	−50.0	
10,000					29	258	−56.1		22	253	−53.0	
11,000					28	220	−59.5		17	217	−53.8	
12,000					28	188	−59.3		14	186	−54.4	
13,000					27	160	−58.1					
14,000					24	136	−58.0					
15,000					21	116	−58.5					
16,000					15	99	−58.5					
17,000					12	84	−58.5					

[1] U. S. Army, Patterson Field (Fairfield), Ohio.
[2] U. S. Navy.
[3] U. S. Army, Barksdale Field, La.
[4] Airplane Jan. 1 to 16, incl., and radiosonde Jan. 17 to 31, inclusive.

NOTE.—All observations taken at 1 a. m., 75th meridian time, except those at Washington, D. C., Lakehurst, N. J., Norfolk, Va., and Pensacola, Fla., where they are taken before 5 a. m., 75th meridian time. At Pearl Harbor, T. H., and Seattle, Wash., observations are taken after sunrise. None of the means included in this table are based on less than 15 surface or 5 standard-level observations. Number of observations refers to pressure only as temperature and humidity data are missing for some observations at certain levels; also, the humidity data are not used in daily observations when the temperature is below −40° C.

LATE REPORT MAY 1939 (Humidity data only)

Altitude (meters) m. s. l.	Relative humidity: At sea (5 m.)	Relative humidity: Halifax, Nova Scotia (5 m.)	Altitude (meters) m. s. l.	Relative humidity: At sea (5 m.)	Relative humidity: Halifax, Nova Scotia (5 m.)
Surface	93	87	4,000	58	67
500	89	82	5,000	55	64
1,000	84	78	6,000	53	61
1,500	77	79	7,000	52	59
2,000	69	78	8,000	52	57
2,500	64	77	9,000	51	
3,000	62	73			

Soundings made by U. S. Coast Guard cutters *Champlain* and *Chelan* of International Ice Patrol. The observations at sea were made in an area extending from latitudes 40° to 44° N. and from longitudes 47° to 53° W.

LATE REPORT JUNE 1939 (Humidity data only)

Altitude (meters) m. s. l.	Relative humidity: At sea (5 m.)	Relative humidity: Halifax, Nova Scotia (5 m.)	Altitude (meters) m. s. l.	Relative humidity: At sea (5 m.)	Relative humidity: Halifax, Nova Scotia (5 m.)
Surface	92	88			
500	90	83	4,000	55	58
1,000	84	77	5,000	51	59
1,500	78	73	6,000	48	55
2,000	76	69	7,000	44	50
2,500	69	65	8,000	43	48
3,000	62	62	9,000	42	48

Soundings made by U. S. Coast Guard cutters *Champlain* and *Chelan* of International Ice Patrol. The observations at sea were made in an area extending from latitudes 40° to 44° N. and from longitudes 47° to 53° W.

TABLE 2.—*Free-air resultant winds based on pilot-balloon observations made near 5 p. m. (75th meridian time) during January 1940*

[Directions given in degrees from North (N=360°, E=90°, S=180°, W=270°).—Velocities in meters per second]

Altitude (meters) m. s. l.	Abilene, Tex. (537 m.)			Albuquerque, N. Mex. (1,554 m.)			Atlanta, Ga. (299 m.)			Billings, Mont. (1,095 m.)			Bismarck, N. Dak. (512 m.)			Boise, Idaho (870 m.)			Brownsville, Tex. (7 m.)		
	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity
Surface	30	314	1.4	31	296	1.6	26	307	4.4	29	244	3.3	31	292	2.7	29	140	1.1	25	46	2.1
500							26	304	5.1										25	85	1.8
1,000	29	284	2.0				25	312	6.6				30	301	7.1	29	145	1.9	21	164	1.8
1,500	28	288	4.8				24	308	8.1	29	255	6.0	24	307	6.1	29	168	2.0	16	257	2.4
2,000	26	287	5.4	31	291	2.9	22	297	11.0	28	280	6.9	20	302	7.3	29	223	1.6	10	291	4.2
2,500	26	286	9.0	31	296	6.0	20	289	15.0	24	289	8.9	20	308	9.1	24	264	4.8			
3,000	25	287	12.5	30	298	8.9	21	283	17.4	24	295	8.7	19	305	9.2	20	291	7.0			
4,000	24	291	16.1	23	300	13.6	20	277	23.0	20	307	13.8	14	308	11.7	15	293	7.6			
5,000	23	292	20.0	19	295	14.4	18	274	28.6	17	308	16.9				12	274	8.5			
6,000	20	291	21.2	18	294	16.3	18	268	33.0	16	309	19.1									
8,000	17	286	23.5	14	300	17.4				13	309	25.2									
10,000	14	288	23.8	11	296	24.2															

Altitude (meters) m. s. l.	Buffalo, N. Y. (220 m.)			Burlington, Vt. (132 m.)			Charleston, S. C. (18 m.)			Chicago, Ill. (192 m.)			Cincinnati, Ohio (157 m.)			Denver, Colo. (1,627 m.)		
	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity
Surface	27	256	4.2	31	306	0.6	26	277	2.3	30	272	3.5	30	230	2.6	29	49	0.7
500	27	250	5.1	30	282	2.5	26	278	3.9	30	278	3.8	30	244	4.1			
1,000	22	257	7.0	27	288	6.2	24	286	6.0	23	297	7.6	23	273	6.8			
1,500	15	282	5.5	24	306	7.4	23	288	9.5	19	305	10.7	20	287	10.2			
2,000	11	276	5.9	18	308	7.1	23	283	13.2	18	305	12.1	17	292	12.5	29	338	1.3
2,500				13	307	7.6	21	276	14.0	18	305	13.4	14	296	14.1	25	307	3.9
3,000							18	272	17.1	17	305	14.4	12	301	14.7	25	300	6.7
4,000																25	309	12.7
5,000																24	305	15.5
6,000																22	304	17.9
8,000																18	302	26.4
10,000																11	296	26.8

Altitude (meters) m. s. l.	El Paso, Tex. (1,196 m.)			Ely, Nev. (1,910 m.)			Grand Junction, Colo. (1,413 m.)			Greensboro, N. C. (271 m.)			Havre, Mont. (766 m.)			Jacksonville, Fla. (14 m.)			Las Vegas, Nev. (570 m.)		
	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity
Surface	30	281	2.1	28	128	0.8	29	206	0.3	26	280	2.5	26	280	1.5	31	303	1.6	31	70	1.3
500										26	286	3.6				30	281	3.6			
1,000										26	291	5.2	26	279	4.1	28	278	6.3	31	68	2.0
1,500	30	281	2.5				29	186	.4	26	300	8.2	26	285	7.8	26	279	8.9	29	29	.8
2,000	28	284	3.8	28	135	.7	29	93	.1	24	294	11.5	26	293	8.9	23	284	12.3	28	28	1.3
2,500	28	289	7.4	28	245	1.4	26	241	1.2	24	290	14.3	20	290	10.6	22	279	14.4	27	287	2.7
3,000	27	286	9.9	26	289	2.4	26	278	3.6	23	286	18.0	18	292	11.4	22	275	16.7	27	278	4.3
4,000	25	288	11.6	24	303	7.7	17	303	7.6	22	283	23.0				21	274	23.2	27	290	7.8
5,000	23	279	11.5	21	304	10.1	13	303	11.2	21	281	31.0				19	274	28.0	26	291	10.1
6,000	17	278	11.6	16	309	10.6				20	278	36.7				18	275	32.2	22	297	13.3
8,000	12	270	11.7	12	302	9.6				16	271	47.8							17	288	14.4
10,000										11	266	51.7							12	294	13.8

Altitude (meters) m. s. l.	Little Rock, Ark. (79 m.)			Medford, Oreg. (410 m.)			Miami, Fla. (10 m.)			Minneapolis, Minn. (261 m.)			Mobile, Ala. (10 m.)			Nashville, Tenn. (194 m.)		
	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity
Surface	28	349	1.4	29	340	0.6	31	320	1.1	30	292	3.7	30	341	2.0	27	287	2.1
500	28	294	2.6	29	83	.2	31	306	2.1	30	298	5.6	29	326	3.0	27	273	3.1
1,000	25	286	4.3	28	156	4.2	29	286	3.7	27	328	7.5	28	318	4.9	26	282	3.8
1,500	25	311	7.8	27	174	5.7	29	277	6.0	26	332	8.9	28	294	7.3	24	300	8.1
2,000	25	305	9.7	26	202	6.6	26	274	8.6	22	330	11.0	27	287	10.7	19	301	10.4
2,500	22	301	13.5	24	210	6.2	24	273	10.6	19	331	11.2	26	285	13.7	19	296	12.7
3,000	21	300	16.0	23	216	6.8	23	275	12.7	16	332	12.4	24	282	16.5	16	298	14.5
4,000	17	301	21.0	19	250	4.5	20	265	18.5	12	318	14.8	16	276	19.4	11	292	19.7
5,000	11	291	23.3	16	283	9.1	19	260	21.6	11	324	16.4	12	277	21.2			
6,000				15	280	8.6	16	260	26.2									
8,000				10	309	13.9	11	258	34.8									
10,000																		

Altitude (meters) m. s. l.	New York, N. Y. (15 m.)			Oakland, Calif. (8 m.)			Oklahoma City, Okla. (402 m.)			Omaha, Nebr. (306 m.)			Phoenix, Ariz. (344 m.)			Rapid City, S. Dak. (982 m.)			St. Louis, Mo. (181 m.)		
	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity
Surface	29	297	5.4	27	157	1.3	28	339	4.1	29	316	3.8	31	279	0.1	29	337	3.9	27	279	3.5
500	29	302	6.6	27	158	2.1	28	341	4.0	29	318	4.8	31	228	0.6				27	281	7.4
1,000	27	308	8.8	22	171	2.5	28	325	4.4	29	327	7.3	31	255	0.8	29	337	4.1	27	296	8.9
1,500	24	302	9.5	21	226	3.2	27	301	6.7	27	328	8.6	31	249	1.7	29	317	6.7	23	294	10.0
2,000	18	295	10.3	19	224	4.0	22	296	9.3	21	325	9.8	31	266	3.0	26	313	8.0	20	302	10.3
2,500	16	292	12.8	18	231	3.4	22	297	10.9	21	322	10.2	29	288	4.0	26	313	8.9	17	305	11.1
3,000	14	292	15.1	16	246	3.6	20	304	12.8	21	319	12.3	29	292	5.4	24	314	11.6	15	298	10.7
4,000				14	219	6.5	20	298	17.7	21	317	16.5	22	298	7.9	18	309	13.7			
5,000				10	252	3.8	19	299	23.0	20	316	20.5	17	296	9.5	17	317	15.7			
6,000							18	300	26.1	19	319	21.5	11	300	9.7	15	316	20.2			
8,000										19	315	26.4				10	317	26.6			
10,000										12	310	28.6									

Altitude (meters) m. s. l.	San Antonio, Tex. (183 m.)			San Diego, Calif. (15 m.)			Sault Ste. Marie, Mich. (230 m.)			Seattle, Wash. (14 m.)			Spokane, Wash. (603 m.)			Washington, D. C. (10 m.)		
	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity
Surface	31	28	2.0	28	268	2.5	24	248	0.8	28	141	0.9	30	82	2.0	29	302	3.3
500	31	33	2.1	28	266	1.7	24	263	1.5	28	136	3.3				29	303	6.8
1,000	30	320	1.6	25	138	1.2	19	280	3.1	27	145	4.5	30	110	2.1	28	292	8.1
1,500	25	293	4.9	23	111	0.6	12	300	3.2	24	190	3.1	27	207	1.7	27	295	9.0
2,000	25	284	6.5	21	272	0.4				18	200	4.3	22	243	2.0	23	296	9.9
2,500	22	288	8.2	21	268	2.1				16	195	4.0	19	267	3.8	21	293	11.8
3,000	22	288	9.7	17	283	2.5				15	200	2.6	18	285	4.9	18	289	13.8
4,000	21	287	12.4	15	313	5.3				12	210	1.9	13	308	7.3	14	289	18.0
5,000	21	279	13.2	15	308	8.6				10	218	2.7				12	286	20.8
6,000	19	274	13.6	12	304	8.1												
8,000	14	279	13.7															
10,000																		

TABLE 3.—*Maximum free-air wind velocities (M. P. S.), for different sections of the United States*

[Based on pilot-balloon observations during January 1940]

Section	Surface to 2,500 meters (m. s. l.)					Between 2,500 and 5,000 meters (m. s. l.)					Above 5,000 meters (m. s. l.)				
	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Station
Northeast [1]	45.6	SW	1,320	30	Akron, Ohio	43.2	WNW	3,770	17	Columbus, Ohio	40.0	WNW	6,830	6	Columbus, Ohio.
East-Central [2]	39.2	WNW	2,500	5	Elkins, W. Va	49.8	WNW	4,530	17	Knoxville, Tenn	79.5	W	9,120	21	Greensboro, N. C.
Southeast [3]	34.4	WSW	2,010	14	Atlanta, Ga	47.2	WSW	5,000	14	Atlanta, Ga	86.0	W	9,990	15	Atlanta, Ga.
North-Central [4]	34.6	WNW	2,450	15	Detroit, Mich	40.0	WNW	4,070	16	Detroit, Mich	61.6	NW	8,400	11	Huron, S. Dak.
Central [5]	37.4	NNW	1,290	14	Des Moines, Iowa	48.6	WNW	3,520	17	Moline, Ill	66.0	NNW	12,520	29	Omaha, Nebr.
South-Central [6]	38.4	WNW	1,500	13	Dallas, Tex	63.0	W	5,000	12	Amarillo, Tex	72.0	W	11,350	15	Abilene, Tex.
Northwest [7]	36.8	W	1,900	16	Billings, Mont	43.7	NW	4,620	14	Billings, Mont	55.0	NW	8,820	24	Billings, Mont.
West-Central [8]	39.2	WNW	2,480	16	Cheyenne, Wyo	41.0	NNW	4,600	12	Sacramento, Calif	70.4	NW	8,860	6	Modena, Utah.
Southwest [9]	29.3	WNW	2,370	11	El Paso, Tex	37.0	WNW	3,700	28	Albuquerque, N. Mex.	86.0	NNW	7,120	22	Albuquerque, N. Mex.

[1] Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, and northern Ohio.
[2] Delaware, Maryland, Virginia, West Virginia, Southern Ohio, Kentucky, eastern Tennessee, and North Carolina.
[3] South Carolina, Georgia, Florida, and Alabama.
[4] Michigan, Wisconsin, Minnesota, North Dakota, and South Dakota.
[5] Indiana, Illinois, Iowa, Nebraska, Kansas, and Missouri.
[6] Mississippi, Arkansas, Louisiana, Oklahoma, Texas (except El Paso), and western Tennessee.
[7] Montana, Idaho, Washington, and Oregon.
[8] Wyoming, Colorado, Utah, northern Nevada, and northern California.
[9] Southern California, southern Nevada, Arizona, New Mexico, and extreme west Texas.

TABLE 4.—*Mean altitudes and temperatures of significant points identifiable as tropopauses during January 1940, classified according to the potential temperatures (10-degree intervals between 290° and 409° A.) with which they are identified.* (*Based on radiosonde observations*)

Potential temperatures	Albuquerque, N. Mex.			Atlanta, Ga.			Billings, Mont.			Bismarck, N. Dak.			Boise, Idaho			Buffalo, N. Y.			Charleston, S. C.		
	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.
290-299	1	6.4	−39.0	1	5.3	−34.0	2	6.7	−44.0	5	7.4	−50.8	1	7.4	−50.0	11	6.6	−45.4	1	5.8	−36.0
300-309	2	6.5	−32.5	3	7.8	−46.0	10	8.0	−48.8	14	8.8	−57.3	4	9.0	−57.8	24	8.2	−52.3	5	7.5	−43.4
310-319	14	9.4	−52.4	19	9.2	−52.3	30	9.6	−56.8	19	9.9	−61.8	14	9.6	−55.9	17	9.7	−58.2	9	8.8	−46.3
320-329	25	10.9	−59.8	21	10.5	−57.2	19	10.7	−60.6	4	10.5	−60.8	20	10.8	−60.4	6	10.4	−60.2	24	10.2	−53.8
330-339	8	11.8	−62.2	6	11.5	−60.0	9	11.5	−62.1	1	11.4	−61.0	8	11.5	−61.2	3	10.8	−57.3	12	11.4	−59.1
340-349	1	12.4	−63.0	3	12.2	−62.3	1	11.6	−56.0				2	12.8	−64.0				2	12.1	−57.5
350-359				4	13.1	−61.5															
360-369	1	14.7	−69.0																4	13.0	−56.7
370-379	1	14.4	−66.0	2	14.6	−65.0													2	14.6	−64.5
380-389	2	15.6	−68.0	3	14.8	−64.7	1	15.0	−62.0				1	14.6	−63.0				3	14.9	−64.0
390-399	2	15.8	−65.5	4	15.6	−65.5							1	15.6	−67.0				1	16.3	−68.0
400-409	2	16.4	−67.0	4	16.2	−66.8	2	15.8	−63.5												
Weighted means		11.1	−58.1		11.2	−57.3		10.1	−57.2		9.4	−58.9		10.6	−59.2		8.7	−53.7		10.6	−54.0
Mean potential temperature (weighted)	331.8			336.6			321.3			310.1			324.0			308.9			331.6		

Potential temperatures	Denver, Colo.			El Paso, Tex.			Ely, Nev.			Fairbanks, Alaska			Joliet, Ill.			Juneau, Alaska			Lakehurst, N. J.		
	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.
290-299							1	7.0	−43.0	7	7.1	−51.1	2	7.8	−53.5	4	5.7	−32.2	8	6.2	−41.0
300-309	4	8.4	−49.8				3	8.0	−49.0	13	8.4	−54.1	12	8.1	−50.9	10	8.0	−48.4	11	7.7	−47.4
310-319	18	9.4	−55.2	6	9.3	−51.7	17	9.5	−54.6	24	9.7	−59.9	24	9.4	−55.7	15	9.7	−58.1	12	9.4	−54.8
320-329	22	10.7	−59.5	19	10.2	−57.3	31	10.9	−60.5	8	10.6	−60.9	7	10.5	−58.1	3	10.2	−56.3	8	10.3	−57.0
330-339	8	13.3	−62.1	21	11.6	−60.7	9	11.6	−60.9	3	10.2	−53.7	1	10.8	−57.0	2	10.4	−54.5	7	11.2	−59.3
340-349	1	12.9	−68.0	10	12.6	−63.5	2	12.1	−61.5	2	11.6	−61.0				1	11.1	−54.0			
350-359	1	11.8	−55.0							1	13.1	−63.0									
360-369	2	12.8	−56.5	2	14.4	−66.5							1	12.9	−57.0						
370-379	1	13.4	−66.0	4	15.0	−67.8	1	14.8	−65.0										1	13.0	−55.0
380-389	1	14.7	−60.0	3	15.3	−65.0	1	14.9	−65.0										2	13.6	−54.0
390-399	1	15.5	−63.0	1	15.8	−66.0	3	15.4	−65.3	1	14.5	−57.0							1	14.0	−55.0
400-409				6	16.8	−70.2	5	16.4	−65.8				1	15.2	−57.0				1	15.4	−59.0
Weighted means		10.6	−58.0		12.1	−61.0		11.0	−59.1		9.5	−57.4		9.4	−54.9		8.9	−51.9		9.4	−52.0
Mean potential temperature (weighted)	326.1			342.5			332.0			315.5			317.0			312.5			321.0		

TABLE 4.—*Mean altitudes and temperatures of significant points identifiable as tropopauses during January 1940, classified according to the potential temperatures (10-degree intervals between 290° and 409° A.) with which they are identified. (Based on radiosonde observations)*—Con.

Potential temperatures	Medford, Oreg.			Miami, Fla.			Minneapolis, Minn.			Nashville, Tenn.			Oakland, Calif.			Oklahoma City, Okla.			Omaha, Nebr.		
	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.
290-299	2	6.2	−47.0	----	----	----	12	6.8	−46.3	1	5.2	−26.0	----	----	----	2	5.4	−35.5	3	6.4	−40.3
300-309	1	9.0	−55.0	----	----	----	21	8.2	−52.2	8	6.6	−34.4	2	7.0	−34.5	6	6.9	−38.4	18	7.7	−45.1
310-319	13	9.7	−55.8	----	----	----	17	9.7	−59.5	16	8.9	−48.5	16	9.5	−52.0	13	9.7	−55.3	22	9.7	−57.5
320-329	18	11.1	−61.3	9	9.6	−43.0	7	10.4	−60.1	15	10.2	−54.7	23	10.9	−59.8	15	10.9	−61.1	16	10.4	−58.2
330-339	8	11.6	−62.0	20	10.6	−47.0	2	11.4	−58.5	6	11.2	−59.2	14	11.7	−60.3	3	11.5	−61.7	7	11.1	−59.3
340-349	2	12.2	−62.0	19	12.7	−61.8	----	----	----	2	11.7	−57.0	2	12.0	−56.0	2	12.5	−65.0	4	11.9	−61.2
350-359	----	----	----	7	13.8	−65.9	1	11.0	−52.0	2	12.4	−58.0	3	13.5	−66.0	----	----	----	----	----	----
360-369	1	12.9	−46.0	11	14.5	−67.1	1	12.6	−56.0	----	----	----	2	14.1	−64.0	----	----	----	----	----	----
370-379	1	14.2	−65.0	5	15.4	−72.4	1	12.6	−53.0	1	13.2	−56.0	1	13.1	−50.0	----	----	----	2	13.4	−59.5
380-389	----	----	----	8	16.3	−74.2	----	----	----	1	14.7	−63.0	2	15.6	−69.0	----	----	----	1	15.0	−63.0
390-399	2	15.5	−61.5	7	16.8	−73.4	----	----	----	----	----	----	4	15.6	−64.5	----	----	----	1	14.4	−56.0
400-409	1	16.0	−64.0	6	17.6	−76.2	1	15.5	−58.0	1	15.8	−61.0	4	16.6	−68.5	----	----	----	1	16.0	−61.0
Weighted means	----	11.0	−59.1	----	13.3	−61.2	----	9.0	−54.3	----	9.7	−50.2	----	11.6	−58.6	----	9.8	−54.9	----	9.8	−54.5
Mean potential temperature (weighted)	329.4			356.5			312.6			324.6			338.0			318.6			321.7		

Potential temperatures	Phoenix, Ariz.			St. Louis, Mo.			San Antonio, Tex.			Sault Ste. Marie, Mich.			Spokane, Wash.			Washington, D. C.		
	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.
290-299	1	5.1	−28.0	8	6.3	−41.0	----	----	----	22	6.9	−48.6	12	6.6	−42.9	6	6.6	−43.0
300-309	1	7.2	−41.0	19	7.5	−45.8	----	----	----	28	8.4	−55.0	4	8.6	−54.0	15	7.7	−46.2
310-319	11	9.3	−50.5	29	9.5	−55.3	8	9.0	−47.1	17	9.7	−60.5	23	9.4	−54.6	13	9.0	−51.6
320-329	18	10.9	−59.3	11	10.5	−59.3	15	10.2	−52.1	4	10.0	−57.2	23	10.7	−60.8	6	10.4	−57.0
330-339	15	11.6	−60.4	7	11.1	−59.1	23	11.7	−58.7	----	----	----	9	11.8	−63.8	2	10.6	−51.5
340-349	1	13.6	−70.0	3	11.1	−53.3	7	12.5	−61.0	----	----	----	2	12.4	−62.0	----	----	----
350-359	1	14.2	−71.0	1	12.9	−61.0	4	13.1	−61.5	----	----	----	----	----	----	----	----	----
360-369	2	14.2	−63.5	2	12.9	−58.0	6	14.0	−65.5	----	----	----	----	----	----	----	----	----
370-379	----	----	----	4	13.4	−57.5	3	15.1	−69.7	----	----	----	----	----	----	----	----	----
380-389	1	16.0	−71.0	3	13.9	−58.0	4	15.7	−68.8	----	----	----	----	----	----	----	----	----
390-399	2	16.4	−70.0	----	----	----	3	15.9	−65.7	----	----	----	2	15.4	−60.5	----	----	----
400-409	3	16.1	−66.3	1	15.7	−64.0	3	16.6	−66.7	----	----	----	1	14.8	−57.0	----	----	----
Weighted means	----	11.4	−58.4	----	9.6	−53.1	----	12.1	−58.7	----	8.3	−54.5	----	10.0	−56.1	----	8.4	−49.2
Mean potential temperature (weighted)	334.7			322.1			343.8			304.5			319.5			311.0		

RIVERS AND FLOODS

[River and Flood Division, MERRILL BERNARD, in charge]

By BENNETT SWENSON

Precipitation during December 1939 was generally below normal over the country except in the far Northwest. River stages were low throughout the month with only a few exceptions, due to the continued deficiency of precipitation extending from summer and fall months.

In the Columbia Basin a minor rise occurred on December 15 and 16 but no appreciable flooding resulted. The Trinity River at Liberty, Tex., reached 24.3 feet (flood stage 24 feet) on the 27th but no material damage was reported.

During the 3 days, December 8, 9, and 10, the total precipitation at Eureka, Calif., amounted to 7.25 inches, and proportional amounts of precipitation were reported over the Eel River Basin. Only once in 52 years, February 2–4, 1890, has an equal amount of rain occured during the same period of time at Eureka and then there was a total of 8.28 inches. Although this was one of the greatest rains of record in that basin no flood stages were reached. This was due generally to the extremely depleted state of the ground water, the early slackening of the rain in the important Willits drainage area, the pause between intervals of intense precipitation, and the total absence of a snow cover. Some of the creeks in the vicinity of Eureka overflowed their banks on December 10 when 3.37 inches of rain fell within 9 hours.

The month of January 1940 was characterized by extremely low temperatures through the Central and Southern States east of the Rocky Mountains. On the other hand, the States west of the Rocky Mountains had above normal temperatures. Precipitation was deficient in much of the Mississippi drainage and eastward, except in Kansas and the Southeast, and in the Southwest, while

it was abnormally heavy in the Rocky Mountain area and in most of California. Other sections had generally normal or near normal amounts. Snowfall was unusually heavy from the Potomac Valley southward into Virginia and North Carolina.

Near the end of the month the snow cover in the eastern half of the country extended as far south as central or southern Georgia, Alabama, and Mississippi. The cover was fairly heavy in portions of the upper Mississippi and Ohio River Basins, the Potomac and James River Basins and in northern New England. In the far West, mountain snowfall was still deficient in much of Arizona, New Mexico, Nevada, and portions of Montana and Washington.

Ice in the rivers was heavy in most northern and eastern districts with ice covering most of the Ohio River and floating ice persisted in the Mississippi south of Helena, Ark. It was reported that the Cumberland River was entirely frozen over at Nashville, Tenn. The Delaware and Susquehanna Rivers were frozen over the entire month with the ice varying in thickness from 10 to more than 20 inches near the end of the month. At Washington, D. C., above Key Bridge, the ice in the Potomac River measured 12 to 15 inches. Some gorging of ice occurred, principally in the Ohio River, but did not reach any serious proportions. The main difficulty was from hindrance to navigation.

Minor rises occurred in a few rivers during the month but flood stage was reached, or exceeded, only at Clyo, Ga., on the Savannah River, crest 12.2 feet on the 26th; at Blountstown, Fla., on the Apalachicola River, crest 15 feet on the 18th; and at Lock No. 3 on the Tombigbee River, crest 34.5 feet on the 17th. No damage was reported.

Heavy precipitation occurred over the Sacramento Basin, during the month, in contrast to the scanty rainfall over this area during the preceding months of this season. The total monthly rainfall for Sacramento, Calif., was 7.98 inches, the highest of record for any January since 1916. There was a heavy overflow into all bypasses, although flood stage was not reached at any of the reporting stations. The only known damage was from the flooding of about 2,700 acres in the Yolo Bypass, on the 12th, where a total loss of about $57,500, mostly of grain land, was reported.

Abnormally low stages prevailed at a few points, principally in the Mississippi River. The river stage at St. Louis, Mo., on January 16, −6.1 feet, is the absolute lowest stage of record (1861–Jan. 31, 1940); the previous lowest stage was −5.5 feet on December 12 and 13, 1937. The low stage this year was not directly due to an ice gorge (unlike the low stage in December 1937) but to the low volume of water and was only indirectly affected by ice conditions above.

Table of flood stages during December 1939 and January 1940

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
	Feet			*Feet*	
ATLANTIC SLOPE DRAINAGE					
Savannah: Clyo, Ga	11	Jan. 23	Jan. 28	12.2	Jan. 26
EAST GULF OF MEXICO DRAINAGE					
Apalachicola: Blountstown, Fla	15	Jan. 18	Jan. 18	15.0	Jan. 18
Tombigbee: Lock 3 (Whitfield, Ala.)	33	Jan. 15	Jan. 18	34.5	Jan. 17
WEST GULF OF MEXICO DRAINAGE					
Trinity: Liberty, Tex	24	Dec. 26	Dec. 27	24.3	Dec. 27
PACIFIC SLOPE DRAINAGE					
Columbia Basin					
South Yamhill: Willamina, Oreg	8	Dec. 15	(1)	9.6	Dec. 16

1 No record.

WEATHER ON THE ATLANTIC AND PACIFIC OCEANS

[The Marine Division, I. R. TANNEHILL, in charge]

NORTH ATLANTIC OCEAN, JANUARY 1940

By H. C. HUNTER

Atmospheric pressure.—The average pressures were considerably lower than normal from the waters adjoining eastern Canada and the northeastern United States east-southeastward to southwestern Europe and adjacent Africa. The deficiency at Horta, in the Azores, was 7.9 millibars. Near southern Greenland, however, there was a marked excess, and over the northern Gulf of Mexico a moderate excess. The first 10 days over middle and higher latitudes brought lower pressures on the average than the remainder of the month.

The extremes of pressure in available vessel reports were 1,035.6 and 962.2 millibars (30.58 and 28.41 inches). The higher reading was noted on the American steamship *Cities Service Boston* during the forenoon of the 7th near the Chesapeake Capes. On land the New Orleans station noted a like reading on the 25th, and the Julianehaab station an even higher one on the 15th and 16th. The low mark was read on the Danish steamship *Svanhild*, near 45° N., 47° W.; the day was the 7th, as with the high mark, while the hour was noon. Table 1 shows that a slightly lower reading was made at Belle Isle, near northern Newfoundland, on the 4th.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and it shores, January 1940*

Station	Average pressure	Departure	Highest	Date	Lowest	Date
	Millibars	*Millibars*	*Millibars*		*Millibars*	
Julianehaab, Greenland 1	1,005.6	+9.0	1,041	15, 16	971	6
Lisbon, Portugal	1,016.1	−4.9	1,026	26, 27	999	2
Horta, Azores	1,013.4	−7.9	1,029	20	993	1
Belle Isle, Newfoundland 2	1,001.1	−6.0	1,039	14	960	4
Halifax, Nova Scotia	1,011.8	−3.4	1,033	14	990	2
Nantucket	1,013.9	−3.4	1,033	10	999	15
Hatteras	1,018.0	−2.7	1,032	10	989	24
Turks Island	1,016.5	−1.1	1,019	7–9, 11, 28	1,012	10, 29
Key West	1,019.0	−0.3	1,030	28	1,012	23
New Orleans	1,022.7	+2.4	1,036	25	1,005	14

1 For 24 days.
2 For 26 days.

NOTE.—All data based on a. m. observations only, with departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.

Cyclones and gales.—So far as reports show, the month was somewhat less stormy over the North Atlantic than the average January, but it was considerably stormier than the preceding December.

Three LOWS are particularly noteworthy. The earliest was over the central Lake region on the morning of the 5th, with an accompanying secondary over the north-

eastern Gulf of Mexico. These LOWS rapidly advanced and joined as one cyclone at approximately 41° N., 61° W., within 24 hours and this moved to 45° N., 44° W., in another 24 hours. Thence the storm turned toward the north-northeast. Numerous reports of gales due to this LOW have been received and the lowest Atlantic vessel barometer reading, mentioned above, was noted near its center.

The next of the important storms was located over Michigan on the evening of the 14th and near northeastern New England on the morning of the 16th, after which it moved slowly northward. Among reports of high winds noted in connection with this LOW was one of hurricane force (12) met by the U. S. cutter *Cayuga* some distance east of the Maine coast. A veteran vessel captain of Chesapeake Bay rated this storm as the worst experienced in 35 years. The Italian steamship *Fidelitas*, from Casablanca bound for New Orleans, suffered so much injury between Hatteras and Bermuda that the captain turned into Norfolk for repairs.

The third intense storm apparently developed over the western Gulf of Mexico, where its center was noted on the 22d, about 200 miles east of Tampico. The morning of the 23d found this storm over northwestern Florida. The British schooner *Gloria Colita*, which had left Mobile bound southward, on the 21st, was found many days later unmanned and greatly damaged, presumably from encountering the high winds of this cyclone.

By the morning of the 24th the storm was central near Cape Hatteras, very intense, and affecting a large ocean area. Chart XIV indicates the conditions of 7 a. m. (E. S. T.) of that date. The American steamships *Cities Service Koolmotor* and *Henry S. Grove* met winds of hurricane strength off the middle Atlantic coast of the United States this day. The Finnish steamship *Olovsborg*, out from Norfolk the 22d for the Panama Canal and Japan, lost one member of the crew while four others suffered severe injuries, and all the lifeboats were lost, so the vessel returned to Norfolk for extensive repairs. The LOW moved rapidly out to the east-northeastward after the morning of the 24th, but intense winds were noted to and somewhat beyond the 60th meridian.

Elsewhere in this REVIEW is mention of some features of norther weather met on the 19th and 20th over the south-central Gulf of Mexico by the American steamship *Antinous*.

Snow squall over Gulf of Mexico.—At about the same time as the norther just mentioned, a fall of snow, lasting about half an hour, was noted off the southeastern coast of Louisiana, in a latitude where snow at sea is of very unusual occurrence. The vessel was the American steamship *Walter Jennings*, Charles Warner, master, bound from Key West to Galveston. The position and time of the snowfall were about 28° N., 91° W., January 20, 10 a. m.

Ice in coastal waters.—In the harbors, navigable rivers, bays, and sounds of the eastern coast of the United States, as far south as North Carolina, vessels had much trouble with ice during the month, particularly during the second half.

Fog.—Over the main part of the North Atlantic there was exceedingly little fog, as far as reports now at hand indicate. The Grand Banks region seems to have had fog on but 1 day, the 20th, and then over only a small portion. Similarly, near the coast of the North American continent from Nova Scotia to Sandy Hook reports show but little fog.

To southward of Sandy Hook, the waters near the coast, as far as Galveston Bay, had almost everywhere more fog than usual. Observers on many vessels, particularly near the coasts of the Carolinas, commented on the connection between this fog and the great temperature contrast between the very cold air coming from over the continent and the warmer air close to the sea water, especially the water of the Gulf Stream. Several observations mention the fog as only low-lying.

While the fog was rather well distributed as to area near the coasts of the Middle and South Atlantic and Gulf States, save that there was little near Florida, there was irregularity in time distribution. Unusual frequency was evident during the days 12th to 19th, inclusive, and there was scarcely any before the 6th or after the 27th.

Two of the 5°-squares, 25° to 30° N., 90° to 95° W., and 30° to 35° N., 75° to 80° W., had fog on 10 days each, the greatest number of any North Atlantic squares. To the northeastward, the square 35° to 40° N., 70° to 75° W., furnished fog reports on 9 days.

OCEAN GALES AND STORMS, JANUARY 1940

Vessel	Voyage		Position at time of lowest barometer		Gale began January	Time of lowest barometer, January	Gale ended January	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN			° ′	° ′				Millibars					
Exhibitor, Am. S. S.	Gibraltar	New York	36 12 N.	17 54 W.	1	5a, 2	3	993.9	SW	W, 7	NW	SW, 10	SW-W.
Frode, Dan S. S.	Norsundet	Albany	44 23 N.	61 00 W.	2	8a, 2	4	994.3	W	W, 3	W	WSW, 10.	
Winkler, Pan. M. S.	Antwerp	New York	37 12 N.	57 36 W.	2	8a, 2	2	996.3		SW, 10		SW, 11	
Ipswich, Am. S. S.	Lisbon	do	38 42 N.	52 42 W.	2	2p, 2	2	989.2	SSW	SW, 10	WNW	SW, 10	SW-W.
Alexandre Andre, Belg. M. S.	Ghent	Aruba	44 36 N.	20 18 W.	2	6p, 2	3	981.4	NNW	W, 6	WNW	NW, 10	SW-NW.
Winkler, Pan. M. S.	Antwerp	New York	38 00 N.	66 00 W.	4	8a, 4	5	1,006.1		W, 8		W, 10	
Edam, Du. S. S.	do	do	45 36 N.	45 53 W.	2	4a, 5	5	978.2	SSE	W, 9	WNW	W, 9	SW-W.
Svanhild, Dan. S. S.	Kirkwall	Boston	48 21 N.	41 50 W.	3	10a, 5	6	965.6	S	WSW, 8	WNW	W, 10	WSW-WNW.
Aurora, Am. M. S.	Beaumont	New York	[3]36 38 N.	74 13 W.	5	8p, 5	6	1,008.5	NW	W, 5	NW	NW, 10	W-NW.
Meanticut, Am. S. S.	Gibraltar	Baltimore	34 40 N.	61 50 W.	6	4a, 6	7	996.6	SSW	SSW, 9	NW	WNW, 10	SSW-W.
Ipswich, Am. S. S.	Lisbon	New York	39 00 N.	61 18 W.	6	1p, 6	7	984.4	SSW	NW, 11	N	NW, 11	WNW-NW-W.
Alexander Hamilton, U. S. C. G.	On patrol out from Norfolk		41 00 N.	62 06 W.	6	1p, 6	7	988.2	NNW	NNW, 2	NNW	NW, 9	
Bronxville, Nor. M. S.	Gibraltar	Boston	32 53 N.	54 07 W.	5	4p, 6	7	1,002.0	WNW	SW, 9	NNW	W, 11	SW-NNW.
Alberta, Ital. S. S.	do	New York	33 00 N.	63 00 W.	6	4p, 6	7	1,006.3	WSW	W, 9	NW	W, 10	WSW-W.
Express, Am. S. S.	Lisbon	do	39 56 N.	58 30 W.	6	6p, 6	7	978.7	WSW	NW, 11	NW	NW, 11	W-NW.
Royal Arrow, Am. S. S.	New York	Beaumont	[3]28 55 N.	92 10 W.	6	8p, 6	6	1,014.6	N	NE, 4	N	N, 10	NE-N.
Svanhild, Dan. S. S.	Kirkwall	Boston	45 04 N.	47 05 W.	7	12m, 7	9	962.2	N	N, 3	NE	NNW, 11.	
Rotterdam, Du. M. S.	New York	Amsterdam	46 18 N.	37 42 W.	7	10p, 7	8	[3]972.9	SW	SW, 9	SW	SW, 10	None.
City of Savannah, Am. S. S.	do	Savannah	[3]33 35 N.	77 14 W.	7	4a, 8	8	1,008.5	SSE	WSW, 6	WSW	SSE, 10	SSE-WSW.
Exhibitor, Am. S. S.	Gibraltar	New York	37 42 N.	33 18 W.	7	3p, 8	8	992.9	S	S, 8	W	S, 10	S-SW.
Exochorda, Am. S. S.	do	Boston	42 50 N.	38 12 W.	10	2p, 10	10	988.2	SSE	SSW, 9	WNW	SSW, 9	S-W.
Katrine Maersk, Dan. M. S.	Copenhagen	Port Arthur	51 54 N.	25 06 W.	11	10a, 11	11	1,002.7		SSW, 9		SSW, 9	
Gulfpenn, Am. S. S.	Baltimore	Corpus Christi	26 48 N.	91 42 W.	14	4p, 13	14	1,006.8	NNW	S, 3	NNW	NNW, 8	
Burgerdijk, Du. S. S.	Rotterdam	New York	48 30 N.	41 43 W.	15	6a, 15	15	992.8	NNW	WNW, 9	SSW	NNW, 9	ENE-NNW-WSW.

See footnotes at end of table.

OCEAN GALES AND STORMS, JANUARY 1040—Continued

Vessel	Voyage: From—	Voyage: To—	Position at time of lowest barometer: Latitude	Position at time of lowest barometer: Longitude	Gale began January	Time of lowest barometer, January	Gale ended January	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
			° ′	° ′				Millibars					
Cayuga, U. S. C. G.	On patrol out from Boston.		43 42 N.	66 48 W.	15	8p, 15	17	[3] 995.3	ESE	ESE, 8	WSW	ESE, 12	ESE-SW.
Pres. Adams, Am. S. S.	Gibraltar	New York	42 12 N.	57 48 W.	18	8a, 18	18	1,003.1	W	W, 6	WNW	W, 10	
Fred W. Weller, Am. S. S.	Boston	Port Arthur	29 26 N.	93 08 W.	18	12 m, 18	19	1,012.2	N	N, 6	NNW	NNW, 10	E-N.
Delftdijk, Du. M. S.	Rotterdam	New York	47 00 N.	40 24 W.	21	12 m, 21	21	992.2	S	SSW, 9	W	SSW, 9	SSW-W.
Gulfbelle, Am. S. S.	Port Arthur	Providence	26 00 N.	79 40 W.	23	2p, 23	25	1,012.2	ESE	W, 6	NW	W, 9	S-W.
Aurora, Am. M. S.	Beaumont	New York	[2] 26 16 N.	79 51 W.	23	4p, 23	24	1,011.9	SW	W, 6	W	W, 10	SW-W.
G. Harrison Smith, Am. S. S.	New York	Corpus Christi	30 48 N.	77 00 W.	23	9p, 23	24	[3] 1,005.8	SW	W, 8	WNW	W, 10	S-W.
Hastings, Am. S. S.	do	Tampa	33 30 N.	75 30 W.	23	3a, 24	25	992.2	ESE	W, 10	NW	WSW, 11	W-WSW-NW.
Noreg, Nor. M. S.	Philadelphia	Beaumont	33 10 N.	75 10 W.	23	4a, 24	24	994.2	ESE	WSW, 10	NW	NW, 11	WSW-WNW.
Cities Service Koolmotor, Am. S. S.	do	Port Arthur	37 30 N.	74 36 W.	23	5a, 24	24	986.1	E	NE, 12	N	NE, 12	E-N.
San Bruno, Pan. S. S.	Charleston	Boston	37 30 N.	73 00 W.	23	8a, 24	25	983.4	ESE	N, 8	NW	NNE, 9	E-N-NNE.
Henry S. Grove, Am. S. S.	Trinidad	do	36 54 N.	69 12 W.	23	12m, 24	25	976.3	E	NE, 11	WNW	NE, 12	ENE-W-NE.
Pendrecht, Du. M. S.	Bilbao	Port Arthur	31 03 N.	58 34 W.	24	8p, 24	25	1,000.2	W	SSW, 9	NW	SW, 11	S-WSW.
Monbaldo, Ital. S. S.	Lisbon	Philadelphia	33 10 N.	60 00 W.	24	12pm, 25	25	992.6	S	WSW, 10	NW	WSW, 10	WSW-WNW.
Capo Noli, Ital. S. S.	Seville	St. John, N. B.	36 42 N.	57 06 W.	24	4a, 25	25	968.2	SSW	WSW, 10	WNW	WSW, 10	WSW-WNW.
Excalibur, Am. S. S.	Gibraltar	New York	39 36 N.	47 06 W.	28	2p, 29	30	1,003.1	SE	W, 7	W	W, 9	SW-W.
Do.	do	do	39 30 N.	59 18 W.	31	8p, 31	[4] 1	997.6	NW	NE, 5	NW	NW, 9	NE-NW.
Black Tern, Am. S. S.	Durban	Baltimore	30 00 N.	58 30 W.	31	10p, 31	[4] 2	1,002.0	S	W, 8	NW	S, 10	S-NW.
NORTH PACIFIC OCEAN													
Huguenot, Am. S. S.	Portland, Oreg.	Long Beach, Calif.	41 00 N.	124 45 W.	[1] 30	9a, 1	1	1,000.0	ESE	S, 9	S	S, 9	
Kahuku, Am. S. S.	Aberdeen, Wash.	Honolulu	43 00 N.	132 45 W.	[1] 31	4a, 1	1	985.4	SE	SSW, 4	SE	SE, 9	SE-SW.
Gefion, Nor. M. S.	Estero Bay	Yokohama	31 42 N.	148 52 W.	1	2a, 2	2	998.3	W	WSW, 9	WNW	SW, 9	
Pres. Cleveland, Am. S. S.	Honolulu	San Francisco	26 50 N.	147 00 W.	2	2p, 2	2	1,006.1	SW	S, 8	SW	S, 8	SSW-S-SW.
Mapele, Am. S. S.	Tacoma	Honolulu	[2] 40 42 N.	137 18 W.	2	4a, 3	3	979.3	S	S, 8	SW	SSE, 10	S-W.
Kahuku, Am. S. S.	Aberdeen, Wash.	do	40 40 N.	137 00 W.	2	6a, 3	3	984.1	ESE	SSE, 6	W	WNW, 9	SSE-WNW.
San Marcos, Am. S. S.	Olympia, Wash.	San Francisco	40 45 N.	124 50 W.	3	4p, 3	3	1,002.4	SE	SE, 10	SSE	SE, 10	SE-SSW.
Michigan, Am. S. S.	Moji	Portland, Oreg.	44 47 N.	135 12 W.	3	2p, 3	4	979.0	SE	ESE, 2	W	WNW, 10	ESE-SE-WSW.
Republic, U. S. A. T.	Tacoma	Los Angeles	48 12 N.	124 54 W.	4	4a, 4	4	997.6	E	E, 9	SW	E, 9	E-SE.
Makawao, Am. S. S.	Anacortes	Honolulu	31 48 N.	146 30 W.	5	4p, 5	6	998.3	S	SSW, 9	WNW	W, 10	S-SW.
Nitiei Maru, Jap. M. S.	Los Angeles	Yokohama	34 22 N.	173 40 E.	5	3a, 6	6	975.6	E	Var. 1	W	NW, 9	S-Var-NW.
Kahuku, Am. S. S.	Aberdeen, Wash.	Honolulu	35 00 N.	144 20 W.	5	2a, 6	6	992.2	ESE	SW, 6	WNW	W, 10	SW-W.
Gertrude Maersk, Dan. M. S.	Yokohama	Los Angeles	39 00 N.	129 30 W.	6	2a, 7	7	992.2	SE	SE, 6	SE	ESE, 8	
Montgomery, U. S. S.	On patrol out from San Francisco.		41 24 N.	125 18 W.	7	4a, 8	7	997.0	SE	E, 7	SE	SE, 8	S-E.
Nonsuco, Phil. M. S.	Iloilo, P. I.	Los Angeles	33 25 N.	162 48 W.	7	4a, 8	8	983.7	SE	Calm	SE	NE, 10	NE-SSE.
Memphis City, Am. S. S.	Los Angeles	Balboa	13 54 N.	94 18 W.	8	4p, 8	8	1,013.2	NE	N, 7	N	N, 8	
Canton, Swed. M. S.	Bugo, P. I.	San Francisco	34 49 N.	142 21 W.	9	2p, 9	9	1,000.0	NE	NNE, 9	N	NNE, 9	NE-N.
Bonneville, Nor. M. S.	Santa Crutz, P. I.	Los Angeles	32 08 N.	154 57 E.	8	8a, 11	13	999.3	W	WNW, 10	WNW	WNW, 11	WNW-NW.
San Pedro Maru, Jap. M. S.	San Francisco	Yokohama	[2] 32 20 N.	149 28 E.	9	2a, 10	11	[3] 1,001.4	W	W, 9	NW	W, 10	
Texas, Am. S. S.	Masinloc, P. I.	Los Angeles	32 24 N.	179 00 W.	12	Mdt, 12	14	995.6		W, 8	NNW	WNW, 11	
Steelmaker, Am. S. S.	Los Angeles	Balboa	15 54 N.	97 54 W.	14	6a, 14	15	[3] 1,009.5	NE	N, 2	NNW	N, 10	
Mauna Ala, Am. S. S.	Seattle	Honolulu	28 24 N.	151 48 W.	14	2p, 14	15	1,000.3	SW	SSE, 6	W	SW, 8	SSE-W.
Texas, Am. S. S.	Masinloc, P. I.	Los Angeles	[2] 33 00 N.	170 07 W.	15	6a, 15	15	994.2	W	SW, 6	W	W, 9	SSW-W.
Yomachichi, Am. M. S.	Keelung	do	35 36 N.	144 00 W.	15	2 p, 15	15	990.9	SE	S, 8	SSW	S, 9	SE-SSW.
H. D. Collier, Am. S. S.	Balboa	do	13 15 N.	93 00 W.	15	4 p, 15	16	1,011.2	NNW	NNW, 4	NNE	NNE, 8	NNW-NNE.
Bridge, U. S. S.	San Francisco	Honolulu	31 02 N.	137 41 W.	15	7 p, 15	15	1,008.1	S	S, 8	S	S, 8	None.
Kaimoku, Am. S. S.	Seattle	do	39 24 N.	140 12 W.	15	2a, 16	16	1,001.0	SE	SE, 8	S	SE, 8	
Jefferson Myers, Am. S. S.	Balboa	Los Angeles	15 54 N.	94 54 W.	16	4p, 16	16	1,012.5	N	N, 7	NNE	NNE, 9	
Bonneville, Nor. M. S.	Santa Crutz, P. I.	do	31 44 N.	175 17 W.	16	4a, 17	18	996.3	W	W, 11	W	W, 11	
Texas, Am. S. S.	Masinloc, P. I.	do	33 48 N.	160 30 W.	17	1p, 17	18	994.6	WSW	SSW, 6	W	W, 9	SSW-SW.
Gefion, Nor. M. S.	Estero Bay	Yokohama	30 29 N.	152 09 E.	18	2a, 18	18	1,002.6	SW	WSW, 9	NW	WSW, 9	SW-WNW
Mindanao, Phil. S. S.	Manila	Los Angeles	34 30 N.	173 00 W.	17	Mdt. 18	18	984.4	NW	SSE, 9		SSE, 9	
Bonneville, Nor. M. S.	Santa Crutz, P. I.	do	32 30 N.	168 14 W.	18	8p, 18	21	985.4	SW	SW, 7	WNW	WNW, 11	SSE-W.
Grete Maersk, Dan. M. S.	Yokohama	do	44 30 N.	174 00 E.	16	Mdt, 18	19	983.9	NW	NNW, 7	NNW	NNW, 9	
Gefion, Nor. M. S.	Estero Bay	Yokohama	33 12 N.	144 24 E.	19	4a, 20	20	1,009.0	WNW	WNW, 9	NW	WNW, 9	
Kaimoku, Am. S. S.	Seattle	Honolulu	28 50 N.	150 20 W.	19	5a, 20	21	988.8	SSW	SSW, 8	W	W, 10	SSW-W.
Texas, Am. S. S.	Masinloc, P. I.	Los Angeles	34 18 N.	148 00 W.	19	1p, 20	21	979.7	SSE	W, 6	WSW	SW, 10	SW-W-WSW.
West Ira, Am. S. S.	Los Angeles	Balboa	15 48 N.	93 54 W.	20	6p, 20	20	1,011.9	NNE	NE, 5	NE	NNW, 8	
Besholt, Nor. M. S.	Cebu, P. I.	Los Angeles	30 18 N.	164 18 E.	23	11a, 21	23	998.0		SW, 6		WNW, 8	
Ludington, U. S. A. T.	Balboa	San Francisco	14 39 N.	96 08 W.	23	10p, 23	24	1,011.2	NNW	NNW, 9	NE	NE, 9	NNE-NE.
Oregonian, Am. S. S.	do	Los Angeles	13 12 N.	91 00 W.	24	6p, 23	24	1,008.1	NNW	WSW, 2	NNE	NNW, 9	
Texas, Am. S. S.	Masinloc, P. I.	do	34 36 N.	132 18 W.	23	3a, 24	24	1,003.4	S	S, 9	S	S, 9	
Hugenot, Am. S. S.	Portland, Oreg.	do	44 00 N.	124 54 W.	23	4p, 24	25	1,004.7	E	SE, 8	S	SSE, 8	ESE-SSE.
Swiftsure Bank Lightship, U. S.	On station		48 33 N.	125 00 W.	24	—, 25	26	[3] 1,010.5		ESE, 8		E, 9	
Amagisan Maru, Jap. M. S.	Yokohama	do	40 30 N.	135 06 W.	25	3p, 25	26	967.1	E	SSE, 9	S	S, 10	E-S.
Huguenot, Am. S. S.	Portland, Oreg.	do	41 18 N.	124 52 W.	25	8p, 25	26	1,002.7	SE	SE, 9	S	SE, 9	SE-S.
Vega, U. S. S.	Bremerton	San Francisco	46 48 N.	124 42 W.	25	4a, 26	27	997.0	SE	SE, 7	SSE	S, 9	
Panaman, Am. S. S.	Balboa	San Diego	16 36 N.	99 48 W.	25	5p, 26	25	1,011.9		W, 3		NNW, 8	
Makawao, Am. S. S.	Ahukimi, T. H.	San Francisco	34 24 N.	135 06 W.	27	2p, 27	27	996.6	SSE	S, 5	SSW	SSE, 9	SSE-S.
Black Condor, Am. S. S.	Balboa	Los Angeles	14 12 N.	94 30 W.	27	6p, 27	28	1,014.6	N	N, 8	N	N, 10	N-NNE.
Matsonia, Am. S. S.	San Francisco	Honolulu	35 14 N.	130 40 W.	27	8p, 27	28	1,003.1	S	SSW, 9	SW	SSW, 9	S-SW.
Bridge, U. S. S.	Honolulu	San Francisco	26 16 N.	149 03 W.	28	1p, 28	29	996.3	SSW	SSW, 9	W	SSW, 9	SSW-WNW.
Mauna Ala, Am. S. S.	Hilo, T. H.	do	23 30 N.	150 12 W.	28	5p, 28	28	1,003.4	SSW	WSW, 7	WNW	WSW, 8	SW-WSW.
Matsonia, Am. S. S.	San Francisco	Honolulu	31 12 N.	138 23 W.	28	3a, 29	29	992.9	SSE	SW, 9	WNW	SW, 9	S-WNW.
Bridge, U. S. S.	Honolulu	San Francisco	31 30 N.	138 30 W.	30	3p, 30	31	1,004.1	W	W, 8	NW	W, 9	None.
Besholt, Nor. M. S.	Cebu, P. I.	Los Angeles	34 30 N.	138 48 W.	31	3p, 30	31	997.3		NNW, 6		WNW, 8	

[1] December. [2] Position approximate. [3] Barometer uncorrected. [4] February.

NORTH PACIFIC OCEAN, JANUARY 1940

By WILLIS E. HURD

Atmospheric pressure.—Most unusual and persistent conditions of low atmospheric pressure overspread the middle waters of the North Pacific during January 1940. While the center of the Aleutian LOW occupied a normal position over or a little south of the Aleutian Islands, cyclonic conditions spread far to the southward, with the result that, even in the latitudes of Midway Island and Honolulu the customary winter anticyclone was, on the average, completely nonexistent. At Honolulu the average pressure of 1,011.2 millibars (29.86 inches) was 4.7 millibars (0.14 inch) below the normal of the month; while at Midway Island the average pressure of 1,007.7 millibars (29.76 inches) was 9.2 millibars (0.27 inch) below the normal, or the lowest of record there for any month during the past 29 years. Minus pressure departures, though in decreasing value, continued as far to the eastward as the west coast of the United States, and as far to the southwestward as about the 135th meridian of east longitude. The lowest barometer reported by any Pacific vessel this month was 967.1 millibars (28.56 inches) read on the Japanese motorship *Amagisan Maru* on the 25th, near 40° N., 135° W. It was accompanied by a south-southeast gale of force 9.

The North Pacific anticyclone occupied a small region to the southwestward of California. In Asiatic waters the continental anticyclone extended oceanward from the China coast to a little beyond the Nansei Islands.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean, January 1940, at selected stations*

Stations	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Millibars	*Millibars*	*Millibars*		*Millibars*	
Point Barrow	1,022.0	+3.4	1,047	14	988	10
Dutch Harbor	997.8	−3.9	1,021	11	979	22
St. Paul	1,001.2	−2.2	1,021	1	984	23
Kodiak	1,004.2	+2.2	1,025	11	982	16
Juneau	1,012.9	+1.0	1,026	18	987	28
Tatoosh Island	1,014.2	−1.1	1,029	14	994	1
San Francisco	1,016.9	−2.7	1,025	15	1,005	7
Mazatlan	1,014.5	+.3	1,018	25, 28	1,011	13–15, 18
Honolulu	1,011.2	−4.7	1,017	30	1,005	19
Midway Island	1,007.7	−9.2	1,016	4	999	31
Guam	1,010.8	−1.7	1,015	11	1,004	22
Manila	1,012.4	+.2	1,016	26	1,009	15
Hong Kong	1,018.1	−1.5	1,025	23	1,010	15
Naha	1,019.5	+.9	1,026	26	1,012	12, 15
Titijima	1,014.5	−1.8	1,021	11	1,005	13
Petropavlovsk	998.8	−5.3	1,013	31	976	12

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observation.

Extratropical cyclones and gales.—The storminess of January 1940, was abnormal on the North Pacific Ocean. Except to the eastward of the 140th meridian of west longitude, stormy weather to the northward of the 40th parallel was perhaps the least pronounced of record for a winter month in that great region. In fact, for the entire area north of 35° N., and west of 150° W., only 4 or 5 days with gale winds (force 8 to 10) are to be noted in ships' reports.

On the contrary, over the eastern part of the ocean, from northern United States coastal waters, and extending southwestward broadly along the routes toward the Hawaiian Islands, extraordinarily stormy conditions for any winter month prevailed. Here rather densely distributed gales of force 8 to 10 occurred on no less than 20 days, which appears to constitute a record for gale frequency, particularly to the southward of the 35th parallel in these waters.

Another stormy region was the belt of 30° to 35° N., between the meridians of approximately 145° E. and 160° W. Along this strip the heaviest winds of the month occurred, attaining force 11 on the 9th, 10th, 13th, 17th, and 19th.

In these latitudes while en route from the Philippine Islands toward San Pedro, the Norwegian motorship *Bonneville* had probably the most tempestuous voyage of any ship of the month on the North Pacific Ocean. On January 8 she entered the stormy weather belt near 32° N., 145° E. On the 21st she finally emerged from it, near 32° N., 160° W. During the period the vessel encountered daily gales, as strong as force 10 on the 11th, 12th, 16th, and 20th, and as high as force 11 on the 9th, 10th, 17th, and 19th. The lowest barometer read on the *Bonneville* during the voyage was 985.4 millibars (29.10 inches) occurring on the 18th, in 32°30′ N., 168°14′ W.

Along the immediate coast of the United States, principally off Washington and Oregon, ships reported gales on the 1st, 3d, 4th, 7th, 24th, 25th, and 26th, all of force 9 except that of the 7th, southeast, force 8, and that of the 3d, southeast, force 10, both off the coast of southern Oregon. These gales occurred in connection with cyclones centered at some distance to the westward.

Tehuantepecers.—There was considerable wind activity in the Gulf of Tehuantepec during January, with Tehuantepecers reported on 9 days, as follows: Of force 8 on the 8th, 20th, and 25th; of force 9 on the 16th, 23d, and 24th; and of force 10 on the 15th, 27th, and 28th.

Fog.—Fog was reported altogether along the northern routes between 180° and 133° W. on 8 days, during the period from the 18th to the 29th. Along the California-Hawaiian routes, exclusive of coastal waters, there were 9 days with fog, scattered through the month. In California coastal waters ships reported fog on 9 days, and in northern Lower California waters, on 1 day.

ADDITIONAL NOTE ON THE MEXICAN WEST COAST CYCLONE OF OCTOBER 23–25, 1939

By WILLIS E. HURD

In the MONTHLY WEATHER REVIEW, October 1939, under the heading "North Pacific Ocean," mention was made that a tropical cyclone occurred off the Mexican west coast on October 23–25, 1939, and that the American steamer *Nevadan* was reported severely battered by the storm off Manzanillo.

In the issue of the United States Department of Commerce Bureau of Marine Inspection and Navigation Bulletin for December 1939, is quoted the report of Capt. J. H. Masse, of the *Nevadan*, on the ship's experiences in the cyclone while northbound for Los Angeles.

At 6:35 p. m. of October 24 the vessel had Manzanillo Bay light abeam. At 8 p. m. warning was received from San Francisco of a tropical disturbance centered near and southwest of Manzanillo. At 11 p. m., in a fresh gale and noticeably falling barometer, the ship turned left for sea room. Quoting from the captain's report, beginning with 1 a. m. of the 25th:

From one o'clock on the barometer dropped fast. Between four and five a. m. it dropped 1.3 inches to 28.00 and at 5:30 a. m. reached as low as 27.40. The center was passing over the ship. Wind and rain let up, but mountainous seas continued to roll in from all sides * * *.

Immediately the storm center had passed, winds came in once again of hurricane force, with the attending mountainous seas. Visibility was nil; in fact, breathing without a towel over one's nose was difficult, the air was so saturated with sea water. With the great difference of pressure within the ship as against the pressure without and the added impetus of hurricane winds, tar-

paulins on No. 2, 5, 6, and 7 hatches burst open and in some cases blew away, thus allowing the sea water to find itself into the ship. * * * we were on our course for Los Angeles at 9:25 a. m.

The barometer from which the reading of 27.40 inches was taken was carefully tested for temperature and pressure by the Weather Bureau office at San Francisco late in January 1940, and the result indicated that the minimum reading of 27.40 was .05 too low. In accepting 27.45 inches (929.6 millibars) as the correct figure, it remains outstanding as the lowest barometer reading on record in connection with a tropical cyclone occurring in southeastern North Pacific tropical waters.

NOTE.—A report received from the master of the *Nevadan* since the preparation of the foregoing text gives 20° N., 106°21′ W., as the approximate position of the ship at time of lowest barometer.

THE APPROACH OF A GULF OF MEXICO NORTHER JANUARY 19, 1940

By WILLIS E. HURD

During the 19th of January 1940, a strong anticyclone, central over Texas, descended rapidly over the Gulf of Mexico, accompanied by subfreezing temperatures along the Texas coast and strong norther winds over the western and central Gulf.

At local noon of the 19th the American steamer *Antinous*, Colon toward New Orleans, was in latitude 21°44′ N., longitude 86°14′ W., with a northwest wind of force 1, barometer 1,015.9 millibars (30 inches), air temperature 82°, sea temperature 80°, weather fine and clear with a few scattered cumulus clouds, and smooth sea. D. Bolhuis, Second Officer on ship—Capt. C. Reed, Master—sent the Weather Bureau an interesting special report on the meteorological conditions attending the burst of the norther over the southeastern Gulf during the afternoon of the 19th and of its continuance during the forenoon of the 20th. Said Mr. Bolhuis:

At 3 p. m. (C. S. T.) dark clouds were observed on the northern horizon to east and west. By 3:15 p. m. they were advancing rapidly and heavy rain was observed. At 3:25 p. m. the norther struck the vessel, with wind from the northwest, force 5, and very heavy rain squalls; barometer steady at 29.97 inches (1,014.9 millibars); temperature of air 76° and sea at injection, 80°. Vessel steering from noon toward the north-northwest (true) at 13 knots. Heavy rains and steady northwest wind, force 5, continued until 8 p. m., then veering to north-northwest to north, force 6. Overcast with heavy rains, and short, choppy, rough sea and swell. At midnight the sky was overcast, with barometer rising steadily and reading 30.12; temperature of air 66° and of sea at injection 78°.

January 20, midnight till noon: Wind north, force 6, decreasing to force 5 at noon. Very little rain and barometer rising steadily to 30.2 inches (1,022.7 millibars). Noon position by dead reckoning, latitude 25°49′ N., longitude 87°50′ W.; temperature of air 55° and of sea at injection, 78°.

The sea seemed to be at its choppiest and roughest in latitude 23°21′ N., longitude 87°03′ W., near the 100-fathom curve off the northern coast of Yucatan.

LATE REPORT

TYPHOONS AND DEPRESSIONS OVER THE FAR EAST, DECEMBER 1939

BERNARD F. DOUCETTE, S. J.

[Weather Bureau, Manila, P. I.]

Typhoon. November 29–December 5, 1939.—This typhoon first appeared about 150 miles south of Yap, apparently well developed, indicating that it most likely formed far to the east of that locality some time previously. From its position south of Yap it moved along a west-northwesterly course, gradually inclining to the northwest. It crossed Samar passing over the southern and central portions on December 2. It continued along this northwesterly course, the center fortunately moving over the water instead of over the islands, for example avoiding Masbate Island and Sorsogon Province. The center moved along the length of Ragay Gulf and crossed Camarines Norte as it inclined to the north, all the time decreasing in intensity and moving slowly. After December 5 it recurved to the northeast as a weak disturbance which soon disappeared over the ocean east of Luzon.

The newspapers of December 9 reported that the total loss of life due to this typhoon, according to reports received, was 34, all from Masbate Island where the rivers rose suddenly because of the heavy rains. There was great property damage along the course of the center, all due to floods and wind.

The barometric minima received from the stations of Samar, Masbate, and southern Luzon show that the storm was weakening as it progressed over the Archipelago. Borongan, Samar, had 730.50 millimeters (974.9 millibars) as its lowest pressure at 2 p. m. December 2, with southeast winds of force 4. Guiuan, Samar, reported 737.94 millimeters (983.8 millibars) with south winds force 9 at 11 a. m. of the same day. Late in the afternoon of December 2, the center passed between Catbalogan and Calbayog, Samar Island. The minima experienced at these stations were 732.91 millimeters (977.1 millibars) for Catbalogan and 731.64 millimeters (975.4 millibars) for Calbayog. Masbate had 731.65 millimeters (975.5 millibars) as its minimum, with winds from the northwest, force 1, during the morning hours of December 3. At Atimonan, Tayabas Pr., 744.03 millimeters (991.9 millibars) was reported as the minimum, with winds of force 7 from the north-northeast, December 4, at 4 a. m. At almost all of these stations, winds of force 10 to 12 were reported as the storm moved past the locality.

On the days preceding November 29, the upper winds over Guam showed the presence of a rather strong east quadrant current, backing from east-southeast to east-northeast, and with velocities as high as 50 kilometers per hour (Nov. 27). Most of these ascents were short and they do not give a very complete picture of the activity aloft. But after November 28 a strong east-southeast and southeast current set in, with velocities as high as 80 kilometers per hour. The Netherland East Indies stations showed the presence of an extensive southwesterly and westerly current of air flowing toward the typhoon center. Menado was an excellent station for showing that the typhoon was intense. Although the reports were not received every day, yet there were enough to show the presence of a western and southwest quadrant current (depending upon the altitude) over the station, with velocities of 50 kilometers per hour and over at many levels. During these days, as the center approached the Philippines, Zamboanga did not have any definite southwesterly current until after December 1, when the pilots first indicated the approach of air from equatorial regions. After December 2, both Zamboanga and Cebu were in the southwest sector of the storm, with only a few short ascents being made. Manila and the stations of northern Luzon, however had north quadrant winds, strong and persistent. There were some ascents that showed velocities to be 100 kilometers per hour and over, while the usual values reported were between 50 and 80 kilometers per hour. There

was a tendency to shift to the north-northwest or northwest and this combined with the surface winds reported from stations in the Visayan Islands, gives the impression that this current of air from the north was deflected and became part of the southwesterly circulation of the storm, which may have been a factor in the weakening of the typhoon. Over Hong Kong, above the 2,000-meter level, there was a steady westerly current. In the opinion of the writer, this high westerly current was advancing southward during these days. But it was impossible to detect this from the pilot balloon ascents during the period; in fact, it was practically impossible to follow a balloon long enough to determine the presence of such a current, because of the rain and the clouds. But over Indochina on December 5, Saigon pilots showed the presence of west-northwest winds, 5 to 40 kilometers per hour, above 2,000 meters, which is the only ascent that can be used to confirm the opinion that the high westerly current was moving southward. If such really happened over the Philippines, then it is another factor in explaining the recurvature and the weakening of the typhoon.

Typhoon, December 5–11, 1939.—As a depression, intensity unknown, this disturbance formed about 200 miles southwest of Guam, moved west-northwest about 1,000 miles, and then recurved to the northeast, December 9th, over the ocean regions about 600 miles east-northeast of San Bernardino Strait. During recurvature, it manifested itself as a typhoon, retaining this intensity until December 11th, after which the available data indicate that it weakened to a depression or even a low pressure area.

The M. S. *Tai Ping* and the *Besholt* experienced the strength of the storm as they were proceeding to Manila via San Bernardino Strait. On December 10th, 3 to 5 p. m., ship's time, the *Tai Ping* passed through the calm area, which lasted about an hour, the minimum pressure being 714.4 millimeters (952.4 millibars), in latitude 18°12′ N., longitude 135°12′ E. The same day, the M. S. *Besholt* had her lowest pressure, 740.9 millimeters (987.8 millibars) at 11 a. m. ship's time, near latitude 18°19′ N., longitude 134°00′ E., with north winds of force 12, which backed to north-northwest soon after the pressure began to rise.

The pilot-balloon observations reported from Guam during this period showed the existence of a northeast quadrant current, December 4, which changed to a powerful southeast quadrant current (velocities between 50 and 90 kilometers per hour) December 5th and 6th, which weakened on the following days. Over the Philippines, Cebu and Zamboanga had west and southwest quadrant winds, December 5 to 8, with velocities scarcely ever reaching 50 kilometers per hour. The northeast and north quadrant winds, which had been prevailing over northern Luzon, replaced the southwest and west winds as the typhoon recurved. Menado, Celebes Island, however, had southwest, west, or northwest quadrant winds, velocities under 60 kilometers per hour during the whole period.

Typhoon, December 16–25, 1939.—On December 15 there was a low-pressure area east of Mindanao, which intensified into a typhoon, December 16, central about 350 miles east of Surigao. From this position it moved rapidly along a northwesterly course to the regions close to and northeast of San Bernardino Strait, where it changed to the west, thus passing over Albay, Sorsogon, and Camarines Sur Provinces. It continued moving westerly and crossed Bondoc Peninsula and then inclined to the northwest, preliminary to recurvature. The center then moved northerly close to and along the coast, passing east of Manila and entered the Pacific between Infanta and Baler. Over the ocean, it continued along a northeasterly course, moving very slowly December 20 to 22, when about 250 miles east of northern Luzon, and then very rapidly toward the Bonins. The center passed about 100 miles northwest of these islands early on December 24 and crossed the 150th meridian on its way toward the Aleutian Islands.

It is to be noted that this typhoon, when approaching the Archipelago, December 16 and 17, moved about 30 miles per hour, or faster than any other storm except one in 1908. Also on December 20 to 22, when the center appeared to be stationary East of northern Luzon, it is possible that it was moving in a loop, but more observations from the ocean regions are needed to be certain of this.

The station at Sorsogon reported 748.7 millimeters (998.2 millibars) as its minimum, which was the lowest value received. The winds were strong, in general force 6 and 7, with one or two stations reporting force 8, and there was heavy rainfall, especially along the Cagayan River valley and the province of Nueva Ecija of central Luzon. The total number of deaths, reported in the newspapers of December 23, was 33, most of which (19) were in Masbate, and the rest in northern Luzon.

The few days before December 16 showed the existence of a rather strong east and east-southeast current over Guam, the velocities varying from 20 to 70 kilometers per hour weakening after December 16. The reports from the Netherland East Indies showed a distribution similar to that in the beginning of the month (Typhoon November 29 to December 5), but the velocities were much weaker, especially at Menado. As the center approached the Archipelago, Zamboanga and Cebu did not come under the influence of the southwesterly winds until December 17, the velocities at these two stations never reaching 50 kilometers per hour while the typhoon was in existence. Manila had west quadrant winds at isolated levels until December 24, after which the directions were from the north, northeast, or east quadrants. Cebu and Zamboanga did not have southwest or west quadrant winds after December 20.

Typhoon, December 22–26, 1939.—This typhoon probably formed over the Eastern Caroline Islands and moved westerly, first affecting the pressure at Guam on December 22. On the afternoon of that day it was about 200 or 250 miles south of Guam and it moved northwesterly during the night, causing heavy rains and gusty winds over Guam on the morning of December 23. It passed about 150 miles southwest and west of the island and inclined to the north and north-northeast on December 24 and 25 over the regions about 300 miles west of the Mariana group. The afternoon map, December 25, showed the typhoon moving east-northeast or northeast, apparently weakening as it approached the 150th meridian.

At Guam, on the morning of December 23, pressure fell to 748.2 millimeters (997.6 millibars) as the center approached and passed the island to the west; winds were from the east, veering to the southeast, force 9, decreasing to 8 during the forenoon. The S. S. *Washingtonian* came under the influence of the typhoon as it was recurving. The minimum pressure recorded on this ship was 746.5 millimeters (995.3 millibars), in latitude 18°00′ N., longitude 143°48′ E., December 24, 3 p. m., ship's time. The winds were from the south-southeast, force 9. The M. S. *Doña Aurora* also experienced the typhoon winds as it was recurving, but not as much as the *Washingtonian*, for southwest-by-south winds, force 3, were experienced in latitude 22°47′ N., longitude 144°38′ E., with a minimum pressure of 756.8 millimeters (1,009.0 millibars), at 3 p. m., December 24 (ship's time).

The upper winds over Guam, December 20 to 22, were east-northeast, backing to northeast and north-northeast, with velocities from 20 to 67 kilometers per hour. There was no chance for any ascents on December 23, but the pilots of the 24th and 25th showed a south quadrant current, with velocities as high as 70 kilometers per hour and weakening. During the period of this typhoon, the pilots from the Netherland East Indies showed the existence of a persistent southwest and west quadrant current, the stations at Koepang and Menado indicating this very well, and it may be supposed that this air flowed toward and reached the typhoon center.

CLIMATOLOGICAL TABLES

[Climate and Crop Weather Division, J. B. KINCER, in charge]

DESCRIPTION OF TABLES

By R. J. MARTIN

The description of tables and charts which appears in each January issue of the REVIEW has been separated this year into two parts with the chart descriptions immediately following table 4.

Table 1 presents average and extreme values for the 42 climatic sections into which the continental United States is divided, and for the sections of Alaska, Hawaii, and Puerto Rico, and is based on all available data collected by regular and cooperative Weather Bureau stations.

Table 2 gives the data ordinarily needed for climatological studies for about 180 Weather Bureau stations making simultaneous observations at 7:30 a. m. and 7:30 p. m. daily, 75th meridian time, and for about 20 others making only one observation. The altitudes of the instruments above ground are also given.

Beginning with January 1, 1932, all wind movements and velocities published herein are corrected to true values by applying to the anemometer readings, corrections determined by actual tests in wind tunnels and elsewhere.

Table 3 gives, for about 37 stations of the Canadian Meteorological Service, the means of pressure and temperature, total precipitation, depth of snowfall, and the respective departures from normal values, except in the case of snowfall. The sea-level pressures have been computed according to the method described by Prof. F. H. Bigelow in the REVIEW of January 1902, **30**: 13–16.

Table 4 lists the severe local storms reported in the United States during the month. It is compiled from reports furnished mostly by officials of the Weather Bureau. The portions of this table which describe tornadoes and windstorms other than tornadoes are summarized in the December issue of the REVIEW and more complete descriptions of tornadoes, other windstorms, and hailstorms are contained in the United States Meteorological Yearbook.

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

TABLE 1.—*Condensed climatological summary of temperature and precipitation by sections, January 1940*

[For description of tables, see page 32, and of lithograph charts, page 38 of this REVIEW]

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	34.2	−12.2	2 stations	75	[1] 12	St. Bernard	−16	28	4.34	−0.50	Mitchell Dam	8.88	2 stations	1.74
Arizona	44.2	+2.4	do	89	30	Alpine	−15	7	.76	−.54	Junipine	4.26	7 stations	.00
Arkansas	28.0	−13.2	Magnolia	74	11	White Rock	−14	19	1.56	−2.86	St. Francis	4.62	Warren	.64
California	47.0	+2.3	Indio	87	28	Boca	−12	14	8.41	+3.58	Ben Lomond	32.41	2 stations	T
Colorado	19.7	−4.2	Cheyenne Wells	64	30	Fraser	−47	19	1.42	+.64	Wolf Creek Pass	6.86	Redvale	T
Florida	49.7	−9.3	2 stations	87	[1] 13	Mason	8	27	2.58	−.17	Mountain Lake	6.11	Key West	.62
Georgia	35.0	−11.9	Waycross	74	11	La Fayette (near)	−17	27	4.44	+.17	Newnan	7.50	Stillmore	2.15
Idaho	26.2	+2.2	Gooding	57	1	Island Park Dam	−29	19	2.47	+.29	Silver City	6.20	Mackay	.57
Illinois	15.0	−12.6	Cairo	51	14	Freeport	−24	18	1.47	−.91	Golconda	3.04	Pana	.73
Indiana	16.2	−12.8	North Vernon	59	14	Marengo	−21	6	1.67	−1.46	La Porte	3.06	Marengo	.80
Iowa	8.4	−10.1	Thurman	45	31	4 stations	−26	18	.83	−.26	Cedar Rapids	1.72	2 stations	T
Kansas	15.2	−14.6	Elkhart	56	30	Dresden	−24	18	.82	+.15	La Cygne	1.86	Trousdale	.23
Kentucky	21.1	−14.7	Williamsburg	61	14	Shelbyville	−20	19	1.67	−2.82	Mayfield	3.44	Carrollton	.58
Louisiana	39.3	−12.3	Bogalusa	78	12	2 stations	−8	27	2.96	−1.94	Morgan City	6.64	Plain Dealing	1.23
Maryland-Delaware	22.3	−11.5	3 stations	59	14	Oakland, Md	−12	19	2.23	−1.07	Cambridge, Md	4.15	Elkton, Md	.51
Michigan	16.8	−4.1	4 stations	45	[1] 14	Watersmeet	−31	4	2.27	+.38	Chatham	6.71	Flint	.44
Minnesota	4.8	−4.4	Hallock	43	30	3 stations	−40	16	.26	−.49	Isle	.84	Worthington	T
Mississippi	32.8	−14.5	Leakesville	78	12	do	−14	27	3.09	−2.07	Leakesville	5.51	Stoneville	1.08
Missouri	15.5	−15.2	Caruthersville	55	13	St. Joseph (Airport)	−28	26	1.35	−1.04	Caruthersville	2.79	Madison	.52
Montana	14.3	−5.2	Choteau	66	29	2 stations	−40	[1] 5	.66	−.28	Hebgen Dam	3.18	2 stations	T
Nebraska	11.5	−11.4	Fort Robinson	54	29	Gordon	−32	18	.72	+.19	McCool Junction	2.00	Merriman	.10
Nevada	33.7	+4.2	Overton	93	14	Wells	−16	15	2.31	+1.11	Lewers Ranch	14.50	Indian Springs	.07
New England	16.3	−6.3	Brockton, Mass	54	15	2 stations	−26	[1] 7	2.05	−1.43	Collinsville, Conn	3.99	East Barnet, Vt	.54
New Jersey	22.4	−8.5	Belvidere	62	15	Runyon	−13	20	1.94	−1.71	Little Falls	3.47	Pemberton	.98
New Mexico	31.3	−2.2	Lovington	77	15	Eagle Nest	−35	23	.59	+.01	Irvin's Ranch	3.05	3 stations	.00
New York	15.3	−7.8	Jamestown	55	14	Stillwater Reservoir	−39	23	1.70	−1.25	Jamestown	5.14	Whitehall	.30
North Carolina	29.7	−11.8	3 stations	66	[1] 14	Cullowhee	−18	26	3.07	−.71	Manteo	4.82	Elizabethtown	1.34
North Dakota	3.4	−2.8	do	48	29	Dunn Center	−39	4	.10	−.37	Towner	.55	3 stations	.00
Ohio	16.8	−11.6	McConnelsville	62	14	2 stations	−17	19	1.46	−1.63	Jefferson	3.05	Put-in-Bay	.56
Oklahoma	25.3	−12.8	Idabel	74	3	do	−14	7	.79	−.65	Bear Mountain Tower.	2.32	Purcell	.20
Oregon	34.1	+2.3	Port Oxford	78	26	Chemult	−12	13	2.93	−.89	Valsitz	11.13	Hart Mountain	.59
Pennsylvania	19.3	−9.1	8 stations	56	[1] 14	3 stations	−16	[1] 7	1.41	−1.82	Westford	4.74	Wilkes-Barre (airport).	.44
South Carolina	34.4	−11.5	2 stations	67	14	Longcreek (near)	−13	26	3.52	−.06	Edgefield	5.84	Landrum	2.19
South Dakota	7.5	−9.1	Rapid City	58	29	McIntosh	−35	18	.19	−.36	Harvey's Ranch	.79	7 stations	T
Tennessee	24.7	−14.3	Waynesboro	66	14	Coldwater	−22	26	2.02	−2.87	Elkmont	4.20	Embreeville	.79
Texas	38.1	−10.1	Mission	90	13	2 stations	−8	[1] 7	.83	−.86	Matagorda	3.21	Van Horn	.07
Utah	27.5	+2.3	2 stations	70	[1] 30	Woodruff	−40	19	2.24	+1.01	Mt. Baldy Ranger Sta.	8.40	Callao	.03
Virginia	25.0	−11.5	do	64	[1] 14	Mineral	−20	27	2.46	−.85	New Canton	5.04	Mount Weather	1.08
Washington	33.6	+3.5	do	74	[1] 28	Stockdill Ranch	−5	11	2.92	−2.24	Wynoochee Oxbow	15.03	Republic	.60
West Virginia	20.5	−12.1	Winfield Locks	62	14	Benson	−24	19	1.44	−2.21	Pickens No. 2	2.77	London Locks	.70
Wisconsin	9.7	−5.3	Racine	39	14	Mellen	−34	16	.80	−.35	El Dorado	2.29	Holcombe	.14
Wyoming	15.6	−4.3	Shoshoni	60	3	Bedford	−45	19	1.19	+.40	Moose	5.69	Dull Center	.04
Alaska (December)	12.0	+7.2	Treepoint	56	10	Stuyahok	−46	2	3.42	+.97	Latouche	40.68	Tanana	T
Hawaii	69.2	+.8	Mahukona	93	19	Kanalohuluhulu	32	25	5.28	−3.36	Kukui	26.00	Puu Ulaula	.00
Puerto Rico	73.2	+.6	Ponce	92	10	Cayey	51	7	3.86	+.04	Barceloneta	13.33	Ensenada	.12

[1] Other dates also.

TABLE 2.—*Climatological data for Weather Bureau Stations, January 1940*

District and station	Elevation of instruments			Pressure			Temperature of the air										Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation			Wind					Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Barometer above sea level	Thermometer above ground	Anemometer above ground	Station, reduced to mean of 24 hours	Sea level, reduced to mean of 24 hours	Departure from normal	Mean max. + mean min. ÷ 2	Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range				Total	Departure from normal	Days with 0.01 inch or more	Average hourly velocity	Prevailing direction	Maximum velocity: Miles per hour	Maximum velocity: Direction	Maximum velocity: Date						
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
New England							19.5	-5.0										72	2.11	-1.3										4.9		
Eastport	76	67	85	29.78	29.87	-0.13	17.8	-2.6	40	15	24	-6	17	12	37	16	10	71	0.56	-3.4	4	12.2	w.	40	e.	15	13	4	14	5.4	2.6	2.5
Greenville, Maine	1,069	4	41																													
Portland, Maine	103	82	117	29.80	29.93	-.12	19.0	-3.4	44	15	26	-1	17	12	29	16	9	65	3.69	-.3	8	9.1	w.	31	se.	15	20	4	7	3.5	5.7	1.4
Concord	288	54	72	29.62	29.94	-.11	18.0	-3.6	41	15	26	-5	10	10	33	12	9	83	2.33	-.7	10	6.3	nw.	22	w.	16	12	10	9	4.7	9.1	3.5
Burlington	403	11	48	29.51	29.90	-.06	11.6	-7.2	37	15	20	-14	23	4	31	9	6	80	.77	-1.0	7	8.4	s.	43	se.	14	9	3	19	6.7	9.9	4.8
Northfield	876	12	60	28.97	29.97	-.08	8.8	-6.4	37	15	20	-21	18	-2	38	6	5	87	.56	-1.8	10	6.8	sw.	27	s.	14	9	9	13	5.9	6.6	9.5
Boston [1]	29	33	62	29.91	29.94	-.11	23.0	-4.9	52	15	30	8	20	16	22	19	12	64	1.68	-1.9	10	12.9	w.	36	se.	15	15	5	11	4.9	4.6	.1
Nantucket	12	14	90	29.93	29.94	-.10	25.8	-5.5	50	15	31	13	20	21	17	23	17	71	2.37	-1.4	13	15.0	w.	43	se.	15	11	10	10	5.2	13.4	1.0
Block Island	26	11	46	29.63	29.96	-.11	25.2	-5.8	50	15	30	12	20	21	17	23	16	67	2.01	-1.8	6	20.4	w.	43	w.	16	17	8	6	4.0	2.2	T
Providence	159	215	251	29.90	29.97	-.09	22.8	-4.4	52	15	30	7	20	16	22	18	11	66	2.50	-1.2	7	12.8	nw.	42	se.	15	17	4	10	4.1	4.2	.0
Hartford	159	66	100	29.97	29.99	-.08	19.4	-6.1	49	15	28	-5	10	10	31	16	10	70	3.69	-.2	9	8.8	nw.	25	nw.	6	13	8	10	5.0	7.7	.0
New Haven	106	74	153	29.90	30.00	-.08	22.9	-5.3	51	15	30	5	20	16	20	19	12	64	3.07	-.9	8	9.9	n.	30	e.	14	14	7	10	4.4	5.1	.0
Middle Atlantic States							24.3	-7.9										67	1.63	-1.6										5.3		
Albany [1]	292	26	40	29.67	30.00	-.07	15.0	-8.1	40	15	22	-9	10	7	30	13	8	73	1.13	-1.3	11	9.3	nw.	31	nw.	6	8	10	13	6.0	11.5	.3
Binghamton	871	57	79		30.08	.00	17.8	-6.3	45	14	24	-3	10	11				74	.97	-1.5	14	7.8	w.	25	sw.	21	5	8	18		11.6	1.1
New York	314	413	454	29.66	30.01	-.09	25.2	-5.7	53	15	32	9	20	18	22	21	12	58	1.96	-1.7	8	16.9	nw.	47	se.	14	9	12	10	5.1	3.9	.0
Harrisburg [1]	351	30	49	29.68	30.08	-.02	21.8	-7.2	52	14	29	2	20	15	28	19	12	67	1.21	-1.9	6	9.6	w.	27	w.	5	9	6	16	6.5	5.0	T
Philadelphia	114	174	367	29.92	30.06	-.05	25.3	-7.3	56	14	32	5	20	19	23	21	12	57	.96	-2.2	7	12.7	nw.	45	s.	14	11	10	10	5.1	2.9	.0
Reading	323	283	306	29.70	30.08	-.01	23.4	-6.0	53	14	30	2	20	16	21	19	10	56	.66	-2.9	6	12.5	nw.	45	se.	14	11	8	12	5.4	7.6	.0
Scranton	805	72	104	29.13	30.03	-.06	20.2	-6.4	45	15	26	1	20	14	23	17	9	60	.47	-2.6	6	7.8	sw.	31	se.	14	6	13	12	6.6	2.8	.0
Atlantic City	52	37	172	30.00	30.05	-.06	25.0	-7.5	52	14	32	4	20	18	22	21	15	66	1.78	-1.7	7	15.4	w.	52	ne.	24	14	7	10	4.7	13.8	3.8
Sandy Hook	22	10	57	30.00	30.02		24.3	-7.0	51	14	30	8	20	19	17	21	16	72	1.73	-2.2	9	17.3	w.	44	s.	14	11	11	9	5.2	2.3	T
Trenton	190	89	107	29.83	30.05		23.6	-6.9	55	14	30	3	20	17	21	20	13	64	1.52	-1.8	8	9.7	w.	26	nw.	5	10	11	10	5.6	4.4	.0
Baltimore [2]	123	100	215	30.08	30.09	-.03	26.0	-7.8	53	14	32	8	20	20	24	20	14	71	1.81	-1.7	7	11.7	sw.	38	s.	14	15	6	10	4.9	9.6	2.5
Washington	112	62	85	29.97	30.10	-.03	24.9	-8.5	55	14	32	7	29	18	24	21	14	60	2.12	-1.4	7	7.7	nw.	27	nw.	25	14	7	10	4.9	15.3	4.0
Cape Henry	18	8	54	30.05	30.07		31.1	-9.1	63	14	37	16	27	26	28	28	23	72	1.54	-1.6	8	14.3	n.	52	n.	24	9	11	11	5.3	9.0	T
Lynchburg	686	144	184	29.34	30.12	-.01	28.2	-9.3	51	17	36	5	29	20	27	23	15	63	2.86	-.6	9	7.3	nw.	26	nw.	19	15	6	10	4.6	18.5	5.0
Norfolk	91	80	125	29.99	30.09	-.04	31.0	-9.6	63	14	37	11	27	25	25	27	22	72	2.35	-.8	8	9.9	n.	43	ne.	23	12	7	12	5.2	12.7	.5
Richmond [2]	144	11	52	29.91	30.10	-.04	27.3	-10.6	60	14	36	2	26	18	29	20	15	75	3.09	-.1	8	7.7	nw.	30	ne.	24	13	6	12	4.5	22.4	6.5
Wytheville	2,304	49	55	27.60	30.11	-.03	22.2	-10.8	50	12	29	0	27	15	32	19	15	79	1.61	-1.5	7	8.5	w.	25	w.	17	11	7	13	5.8	14.2	4.0
South Atlantic States							35.1	-9.7										72	3.30	-0.3										4.8		
Asheville	2,253	89	104	27.69	30.18	+.03	26.4	-9.0	54	14	35	1	20	18	34	22	17	73	2.13	-1.0	11	9.7	nw.	28	nw.	19	14	2	15	5.5	7.7	T
Charlotte [1]	779	63	86	29.26	30.11	-.04	31.4	-9.8	57	18	40	6	27	23	27	25	19	72	4.00	.0	9	6.4	n.	20	ne.	23	15	4	12	4.6	7.8	3.2
Greensboro [1]	886	6	56	29.14	30.12		27.0		53	17	37	-7	29	17	41	22	17	73	2.36		8	7.4	w.	28	n.	23	16	4	11	4.6	14.5	5.0
Hatteras	11	5	50	30.05	30.06	-.08	37.2	-9.9	64	14	44	19	27	31	28	33	29	80	4.67	+.2	12	15.2	nw.	59	nw.	24	16	4	11	4.6	1.1	.0
Raleigh [2]	376	103	146	29.71	30.11	-.02	31.6	-9.5	63	14	39	8	27	24	26	26	21	72	2.58	-1.1	9	9.0	nw.	29	ne.	23	14	5	12	4.9	5.7	.7
Wilmington	72	73	107	30.03	30.11	-.03	36.9	-9.6	66	14	46	14	28	28	26	31	26	71	3.16	-.1	11	8.6	nw.	30	nw.	8	16	4	11	4.5	1.3	.0
Charleston	48	11	92	30.06	30.12	-.03	40.0	-9.9	66	14	48	19	27	32	22	35	29	70	3.31	+.3	10	9.5	nw.	29	nw.	24	13	6	12	5.1	T	.0
Columbia, S. C.	347	70	91	29.88	30.13	-.02	35.3	-10.7	65	14	44	10	27	26	26	29	24	72	2.49	-.9	8	7.4	ne.	27	ne.	23	16	4	11	4.5	1.5	T
Greenville, S. C.	1,040	70	78	28.97	30.11		31.8	-8.5	57	18	41	8	27	23	29	27	21	69	2.85	-2.0	7	6.2	ne.	25	sw.	14	15	5	11	4.5	7.9	T
Augusta [2]	182	62	77	29.65	30.12	-.04	36.3	-10.7	67	14	46	12	27	27	29	29	21	64	4.66	+.7	9	6.0	nw.	22	w.	14	11	9	11	4.8	.8	.0
Savannah	65	73	152	30.07	30.13	-.02	41.8	-9.6	67	14	52	18	27	32	28	34	28	74	3.31	+.5	9	10.7	nw.	34	w.	24	12	10	9	4.7	T	.0
Jacksonville	43	86	110	30.09	30.13	-.02	45.5	-9.9	72	12	56	17	27	35	33	39	33	70	2.94	+.1	9	8.6	nw.	30	sw.	23	12	8	11	5.0	.0	.0
Florida Peninsula							59.6	-5.9										77	2.22	-0.2										5.0		
Key West [1]	21	10	64	30.08	30.09	-.01	65.4	-4.1	81	13	71	43	28	59	24	59	57	81	.62	-1.3	4	9.9	n.	32	nw.	19	9	9	13	5.6	.0	.0
Miami	25	124	168	30.07	30.10	-.03	61.3	-5.2	81	5	70	31	28	53	26	55	51	75	2.85	+.3	6	9.7	nw.	40	sw.	23	13	9	9	4.8	.0	.0
Tampa [2]	35	88	197	30.12	30.13	+.01	52.0	-8.4	77	13	61	26	28	43	29	46	42	76	3.20	+.5	9	11.3	n.	37	nw.	23	12	13	6	4.7	T	.0
East Gulf States							37.1	-12.3										72	3.92	-1.0										4.8		
Atlanta [1]	976	5	72	29.08	30.16	+.01	29.6	-13.0	59	14	38	4	26	21	33	25	19	68	5.62		8	11.6	nw.	31	nw.	19	16	4	11	4.7	8.3	1.5
Macon [2]	370	79	87		30.14	-.02	35.2	-11.6	66	14	45	10	27	26	31			68	4.93	+.8	6	8.0	nw.	21	nw.	24	10	10	11		3.2	
Thomasville	273	49	58	29.86	30.17		41.4		69	12	52	14	27	31	30	37	31		3.66		8		nnw.				15	12	4	3.5	.0	.0
Apalachicola	35	11	51	30.12	30.15		43.6	-10.1	68	12	52	18	27	35	29	39	34	73	1.86	-1.7	6	9.2	n.	34	nw.	23	10	6	15	5.8	.0	.0
Pensacola	56	149	185	30.12	30.18	+.04	40.8	-11.7	70	12	50	14	27	32	28	37	32	74	2.75	-1.2	9	8.2	n.	30	w.	14	16	9	6	4.0	T	.0
Anniston	741	9																														
Birmingham [2]	630	5	55	29.51	30.21	+.05	30.6	-14.5	65	14	40	1	26	22	32	24	20	77	5.39	-.1	12	6.9	nw.	32	se.	13	12	10	9	5.0	10.0	1.5
Mobile	57	86	161	30.16	30.20	+.05	39.6	-11.9	74	12	49	14	27	30	36	34	30	76	2.65	-2.2	9	11.2	nw.	34	nw.	19	12	11	8	4.8	T	.0
Montgomery [2]	218	92	105	29.92	30.18	+.02	36.2	-12.0	66	14	46	10	27	27	32	29	24	72	3.93	-1.3	8	7.7	nw.	27	w.	14	13	8	10	4.9	1.2	.0
Meridian [2]	375	67	92	29.87	30.21	+.05	33.6	-13.4	69	12	44	2	27	24	35	28		79	3.61	-1.7	12	6.2	n.	27	w.	14	14	3	14	5.4	5.7	T
Vicksburg	247	82	102	29.95	30.22	+.07	34.8	-13.4	68	13	43	6	19	26	31	30	23	66	3.51	-1.9	8	8.7	n.	34	w.	13	13	6	12	5.3	8.0	T
New Orleans [2]	53	76	84	30.17	30.20	+.07	43.0	-11.2	75	11	51	20	19	35	38	37	32	73	5.56	+1.2	9	7.2	ne.	24	w.	7	13	7	11	5.1	.0	.0
West Gulf States							37.1	-10.1										70	1.11	-1.6										5.4		
Shreveport [2]	249	92	227	30.03	30.24	+.10	35.8	-11.2	72	11	45	3	19	27	35	31	26	73	2.24	-1.7	6	11.2	nw.	46	w.	13	16	6	9	4.3	3.0	.0
Bentonville	1,303	12	51	28.84	30.33	+.19	21.2	-12.9	52	16	30	-8	19	12	30				.78	-1.9	8	7.0	nw.	24	w.	13	12	4	15		6.2	.0
Fort Smith	463	57	82	29.78	30.29	+.15	26.4	-13.1	55	16	34	-2	19	18	30	23	16	65	1.07	-1.5	8	8.5	e.	34	w.	13	11	8	12	5.4	9.4	.0
Little Rock [2]	357	94	102	29.96	30.25	+.10	29.0	-12.4	59	11	36	0	19	22	27	24	19	74	1.40	-3.3	7	8.5	nw.	34	w.	14	12	6	13	5.5	5.8	T
Austin [2]	605	68	90	29.55	30.23		40.6	-8.9	75	11	51	13	19	30	37	34	29	69	.63	-1.4	4	7.8	w.	32	nw.	13	10	9	12	5.4	2.0	.0
Brownsville [2]	57	88	96	30.15	30.17		54.2	-5.6	80	12	63	25	23	45	49	48	43	74	.29	-1.2	5	11.6	nw.	38	n.	18	4	8	19	7.5	.0	.0
Corpus Christi [2]	20	11	78	30.15	30.20	+.10	48.4	-7.6	79	13	57	19	19	40	36	42	38	75	.76	-.8	4	10.5	n.	34	n.	18	7	6	18	6.8	1.7	.0
Dallas [2]	512	220	227	29.71	30.26		34.4		71	11	44	6	19	24	35	29	22	68	.80	-1.6	4	12.3	n.	56	w.	13	17	5	9	4.0	4.0	.0
Fort Worth [1]	679	92	110	29.48	30.26	+.14	34.9	-10.5	74	13	45	6	19	24	42	29	22	65	.59	-1.5	3	11.3	nw.	45	w.	13	16	9	6	3.9	4.0	.0
Galveston [2]	54	106	114	30.20	30.21	+.08	44.4	-9.4	66	12	51	15	19	38	34	40	35	74	1.50	-1.8	7	10.8	n.	32	n.	18	7	13	11	5.7	.9	.0
Houston	138	157	190	30.15	30.23		43.1	-9.6	74	12	53	10	19	34	37	35	31	74	1.59	-1.2	5	10.7	n.	34	nw.	13	10	11	10	5.5	3.0	.0
Palestine	510	64	72	29.69	30.25	+.17	36.4	-11.8	73	11	46	5	19	27	41	31	24	64	1.50	-1.9	5	7.6	n.	30	sw.	13	13	9	9	4.8	4.5	.0
Port Arthur	34	59	134	30.18	30.22		41.6		70	11	50	13	19	33	32				1.66	-2.0	7	12.7	n.	38	nw.	13	9	9	13	6.0	1.8	.0
San Antonio [2]	693	111	301	29.59	30.22	+.12	43.8	-8.5	77	11	54	15	19	34	37	38	32	68	.64	-.8	5	10.4	n.	38	n.	13	10	8	13	5.9	3.2	.0
Ohio Valley and Tennessee							20.8	-12.6										80	1.71	-2.1										6.3		
Chattanooga [2]	762	71	214	29.42	30.20	+0.04	28.6	-12.6	54	17	37	0	19	21	26	23	18	71	2.84	-2.4	12	8.4	w.	30	w.	14	13	5	13	5.1	11.6	1.7
Knoxville [2]	995	66	84	29.09	30.18	+.03	26.7	-12.1	58	13	34	-3	28	19	31	22	17	73	2.31	-2.4	11	5.9	w.	23	w.	13	13	5	13	5.0	13.6	2.5
Memphis [2]	399	78	86	29.91	30.24	+.08	27.2	-13.7	60	13	38	-3	19	20	26	23	20	82	1.83	-3.0	7	8.5	n.	36	w.	14	15	4	12	5.0	4.6	.0
Nashville [2]	546	168	188	29.54	30.20	+.04	24.8	-13.8	57	14	33	-5	19	16	26	21	16	73	1.13	-3.6	9	9.0	w.	36	s.	14	9	12	10	5.5	6.1	T

See footnotes at end of table.

TABLE 2.—*Climatological data for Weather Bureau Stations, January 1940*—Continued

District and station	Elevation of instruments			Pressure			Temperature of the air									Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation			Wind					Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Barometer above sea level	Thermometer above ground	Anemometer above ground	Station, reduced to mean of 24 hours	Sea level, reduced to mean of 24 hours	Departure from normal	Mean max. + mean min. ÷ 2	Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range				Total	Departure from normal	Days with 0.01 inch or more	Average hourly velocity	Prevailing direction	Maximum velocity: Miles per hour	Maximum velocity: Direction	Maximum velocity: Date						
Ohio Valley and Tennessee—Cont.	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
Lexington	989	6	----				20.0	−12.9	52	14	28	−12	19	12	31				2.31	−1.9	14	----	nw.							----	17.8	1.5
Louisville [2]	525	106	120	29.57	30.18	+.04	20.4	−14.0	54	14	28	−13	19	13	25	17	14	81	1.56	−2.4	13	9.2	sw.	45	sw.	14	11	8	12	5.5	8.2	T
Evansville	431	76	116	29.72	30.21	+.07	19.5	−14.0	51	14	27	−10	19	12	25	18	14	78	2.36	−1.4	14	9.0	w.	35	sw.	14	8	8	15	6.4	13.6	T
Indianapolis [2]	823	98	129	29.24	30.15	+.03	16.8	−11.6	47	14	24	−11	19	10	22	13	11	87	1.38	−1.6	13	8.5	w.	30	sw.	14	9	7	15	6.2	5.3	1.1
Terre Haute	575	63	149	29.52	30.17	-----	16.8	-----	46	14	25	−12	19	9	25	16	13	83	1.87	−.8	12	9.4	sw.	37	sw.	14	11	4	16	6.2	9.0	.1
Cincinnati [2]	627	11	51	29.60	30.17	+.05	19.0	−11.3	52	14	26	−12	19	12	25	17	14	83	1.27	−2.2	12	8.8	sw.	32	sw.	14	10	5	16	6.2	7.6	1.1
Columbus [2]	822	90	110	29.19	30.13	+.02	17.8	−10.8	50	14	25	−11	19	10	26	14	10	81	1.44	−1.6	12	10.5	sw.	43	sw.	14	7	5	19	7.3	8.5	1.8
Dayton	900	186	213	29.13	30.14	-----	17.4	−12.1	51	14	24	−11	19	10	26	16	13	81	1.71	−1.5	14	10.7	sw.	46	sw.	14	9	5	17	6.4	7.5	1.7
Elkins [2]	1,947	65	83	27.90	30.12	.00	18.8	−11.6	51	14	26	−7	19	12	34	16	12	81	1.44	−2.3	16	6.8	w.	27	se.	14	2	4	25	8.5	24.6	4.0
Parkersburg	637	77	84	29.42	30.14	+.02	20.2	−12.3	54	14	27	−6	19	14	28	18	15	80	1.25	−2.3	14	6.7	sw.	25	nw.	5	7	4	20	7.3	9.2	1.8
Pittsburgh [1]	1,273	39	54	28.67	30.09	−.02	17.4	−13.3	50	14	24	−9	19	11	26	16	12	81	.88	−2.2	15	12.2	sw.	34	sw.	15	2	7	22	8.1	8.9	1.0
Lower Lake Region							17.1	−7.4										84	1.68	−0.9										7.9		
Buffalo [2]	168	243	280	29.23	30.03	−.04	18.1	−6.5	47	14	23	−3	19	13	18	16	13	86	2.47	−.8	25	1.9	w.	54	sw.	21	2	7	22	8.0	27.6	7.3
Canton	448	10	61	29.49	30.01	-----	8.4	−7.9	41	14	18	−22	23	−1	37	7	6	92	.91	−1.6	11	8.5	w.	31	se.	14	10	3	18	6.1	8.3	5.4
Ithaca	836	77	100	29.08	30.02	-----	18.4	−5.9	42	15	24	0	19	12	26	16	13	82	.72	−1.5	13	10.0	nw.	49	se.	14	3	5	23	8.1	5.4	.5
Oswego	335	71	85	29.63	30.01	−.06	17.2	−6.7	41	13	23	−1	7	11	22	16	11	76	3.83	+.9	20	11.6	nw.	33	se.	14	5	3	23	8.1	46.7	12.8
Rochester [2]	523	86	102	29.40	30.03	−.04	18.4	−6.2	45	14	23	−1	19	14	20	15	13	86	1.26	−1.6	20	10.8	w.	29	sw.	21	2	7	22	8.2	9.3	5.2
Syracuse [2]	506	65	79	29.56	30.03	−.04	17.2	−6.9	46	14	23	0	17	11	22	13	11	87	1.72	−1.3	22	7.5	sw.	21	sw.	21	3	6	22	7.9	32.2	7.5
Erie	714	57	81	29.25	30.05	−.03	19.0	−7.8	45	14	24	−8	19	14	20	18	15	83	2.15	−.6	20	10.3	s.	35	se.	14	2	7	22	8.4	18.9	5.8
Cleveland [2]	762	267	318	29.18	30.09	.00	19.6	−6.9	52	14	25	−9	19	14	20	15	12	83	1.35	−1.2	21	15.8	sw.	49	sw.	14	0	7	24	8.5	17.1	2.1
Sandusky	629	5	67	29.37	30.08	−.01	18.0	−8.3	49	14	25	−11	19	11	25	----	----	----	1.36	−.9	20	10.8	sw.	32	sw.	14	2	7	22	8.1	9.7	1.0
Toledo [2]	628	79	87	29.38	30.10	−.01	17.4	−8.4	48	14	23	−13	19	12	20	14	11	81	1.26	−.9	16	11.4	w.	31	se.	14	3	7	21	7.9	7.2	.7
Fort Wayne	857	69	84	29.17	30.11	-----	14.6	−11.6	46	14	21	−14	19	8	25	13	10	87	1.66	−.7	15	10.5	w.	41	sw.	14	6	7	18	7.2	10.6	1.2
Detroit [1]	626	5	78	29.36	30.06	−.02	19.0	−5.4	43	14	24	−9	19	14	19	18	16	86	1.41	−.7	15	11.3	w.	34	w.	15	1	5	25	8.6	5.9	1.2
Upper Lake Region							15.5	−2.6										82	1.57	−0.3										7.6		
Alpena	609	13	89	29.32	30.01	−.03	18.3	−.8	37	14	24	−5	17	12	27	17	13	79	1.83	−.1	16	11.0	nw.	38	se.	14	3	8	20	7.7	11.5	2.0
Escanaba	612	51	72																													
Grand Rapids [2]	707	70	244	29.26	30.04	−.02	20.0	−4.5	42	14	25	−4	19	15	23	16	15	90	1.60	−.7	21	10.5	w.	37	s.	14	1	3	27	9.1	16.1	5.3
Lansing	878	5	90	29.06	30.04	-----	18.0	−4.4	42	14	24	−11	19	12	25	17	15	89	1.35	−.5	10	9.2	w.	30	s.	14	0	7	24	8.6	10.6	4.5
Ludington	637	60	66																													
Marquette	734	44	69	29.19	30.03	−.01	17.6	+1.3	32	30	23	−10	18	12	29	16	13	83	2.48	+.2	17	7.9	nw.	31	nw.	14	0	4	27	9.2	25.5	14.5
Sault Sainte Marie [1]	724	5	33	29.17	30.01	−.02	12.2	−1.1	35	14	20	−23	17	4	38	11	9	90	2.67	+.7	18	7.7	se.	35	nw.	15	4	5	22	7.9	28.3	13.8
Chicago	673	7	131	29.35	20.12	+.02	16.2	−7.5	40	14	22	−14	18	10	27	15	11	77	1.25	−.6	10	10.6	w.	27	w.	14	10	6	15	6.3	8.6	1.1
Green Bay	617	109	141	29.36	30.07	+.01	13.8	−1.9	33	11	21	−18	18	7	32	13	7	71	.99	−.6	8	10.2	w.	35	nw.	14	9	5	17	7.1	13.8	13.1
Milwaukee [2]	681	97	221	29.31	30.11	+.03	15.7	−4.9	37	14	22	−15	18	9	27	12	8	81	1.57	−.2	8	12.2	w.	34	nw.	14	9	8	14	6.2	9.5	.9
Duluth	1,133	5	47	28.82	30.12	+.03	8.1	+.2	31	31	16	−22	16	0	31	6	3	82	.27	−.7	9	13.2	nw.	43	nw.	20	9	10	12	5.9	3.6	1.5
North Dakota							2.7	−1.9										87	0.09	−0.4										5.6		
Moorhead, Minn.	940	50	58	20.20	30.26	+.12	4.0	+.2	41	30	13	−22	18	−5	36	2	0	89	.13	−.5	6	8.0	nw.	21	nw.	15	12	8	11	5.3	2.6	.7
Bismarck [2]	1,677	8	57	28.41	30.32	+.19	2.2	−5.6	44	30	14	−26	2	−9	39	1	−1	89	.02	−.4	2	9.8	nw.	34	nw.	18	8	6	17	6.6	.1	T
Devils Lake	1,478	11	44	28.56	30.24	+.12	1.6	−.2	40	30	11	−26	17	−8	30	1	0	94	.15	−.3	6	9.0	nw.	25	nw.	18	6	14	11	6.2	2.1	.6
Lemmon, S. Dak.	2,602	4	38																													
Grand Forks [2]	832	11	71				2.8	−.7	40	30	13	−25	17	−8	32	2	−3		.12	−.4	5		nw.								1.3	1.2
Williston	1,878	42	50	28.19	30.31	+.20	3.1	−3.3	40	29	13	−26	18	−7	34	2	−2	76	.04	−.5	3	6.7	w.	36	n.	14	16	7	8	4.3	.3	1.9
Upper Mississippi Valley							12.0	−9.2										83	1.05	−0.5										5.6		
Mpls.—St. Paul, Minn. [1]	838	32	61	29.22	30.20	+.09	6.5	−6.2	35	31	14	−22	18	−1	30	5	2	82	.37	−.5	10	9.8	nw.	32	nw.	14	10	8	13	5.6	5.0	3.8
Springfield, Minn.	1,025	4	42	29.06	30.24		6.0		37	11	15	−23	19	−3	36	6	1		0.06		2	7.5	wnw							3.8		T
La Crosse [2]	714	11	48	29.40	30.18	+.07	10.8	−5.3	33	11	18	−19	18	4	35	7	5	87	.61	−.5	6	5.6	w.	21	nw.	14	8	8	15	6.3	8.3	2.7
Madison	974	70	78	29.14	30.13	+.03	11.0	−5.7	33	11	18	−20	18	4	26	9	6	82	1.25	−.1	5	8.6	w.	30	nw.	14	8	9	15	6.2	12.7	8.5
Charles City	1,015	10	51	29.05	30.22	+.08	8.5	−5.2	34	31	16	−21	18	1	29	7	5	87	.53	−.5	4	6.7	nw.	19	nw.	14	15	4	12	4.7	7.2	2.5
Davenport	606	66	161	29.49	30.20	+.08	12.3	−9.5	35	11	20	−17	18	5	25	11	7	79	1.55	+.1	6	10.5	w.	30	nw.	14	12	6	13	5.3	13.7	7.0
Des Moines	861	5	99	29.13	30.23	+.09	10.4	−9.7	39	31	18	−18	18	3	32	8	5	87	.80	−.3	5	10.6	nw.	30	nw.	14	14	6	11	4.6	9.2	2.3
Dubuque	690	60	79	29.37	30.17	−.05	11.8	−7.3	34	31	19	−18	18	4	34	10	8	84	1.56	+.3	7	6.9	nw.	24	nw.	14	11	7	13	5.7	17.2	7.7
Keokuk	614	64	78	29.52	30.22	+.08	12.2	−12.7	39	31	20	−13	19	4	31	10	7	79	.91	−.6	10	8.0	w.	30	nw.	14	9	11	11	5.5	12.1	5.9
Cairo	358	87	93	29.83	30.23	+.07	22.0	−12.9	51	14	30	−6	19	14	28	19	15	75	2.64	−1.1	13	8.4	nw.	37	sw.	14	9	9	13	5.9	7.8	.3
Peoria [2]	609	11	45	29.42	30.18	+.06	13.3	−9.8	37	31	21	−13	19	6	27	11	9	88	.84	−.9	9	6.9	w.	24	w.	14	13	9	9	4.8	4.3	1.0
Springfield, Ill. [2]	636	5	191	29.49	30.20	+.07	14.5	−12.0	37	11	22	−12	19	8	28	11	9	80	1.21	−.9	10	11.2	w.	28	w.	14	9	4	18	6.6	8.2	1.3
St. Louis [3]	568	179	303	29.58	30.22	+.08	17.2	−13.9	43	11	25	−12	19	10	23	15	10	74	1.33	−1.0	12	11.6	nw.	32	w.	14	11	6	14	5.9	10.6	.1
Missouri Valley							10.8	−12.8										81	0.92	−0.1										5.3		
Columbia, Mo. [2]	784	6	66	29.36	30.26	+.13	14.0	−15.2	40	16	22	−15	19	5	30	10	6	75	1.62	−.3	12	7.4	w.	21	w.	14	6	13	12	5.8	12.4	1.8
Kansas City [1]	750	38	76	29.42	30.28	+.13	12.8	−15.4	37	11	22	−12	18	4	33	11	6	73	1.26	+.1	9	9.6	nw.	33	nw.	14	11	7	13	5.5	12.8	1.5
St. Joseph [2]	967	11	40	29.35	30.29	-----	11.5	−14.0	38	31	20	−15	18	3	27	8	5	87	1.63	+.4	7	8.4	nw.	26	nw.	14	13	7	11	4.9	20.1	7.0
Springfield, Mo. [2]	1,324	5	78	28.73	30.25	+.11	16.0	−17.5	48	31	25	−12	5	7	35	14	11	80	.89	−1.4	10	9.2	w.	27	w.	14	9	7	15	6.5	11.7	.0
Topeka	987	65	87	29.17	30.29	-----	13.8	−13.8	39	11	22	−11	18	6	30	12	7	73	1.32	+.4	9	8.8	nw.	25	nw.	18	11	10	10	5.1	14.7	6.5
Lincoln [2]	1,189	11	81	28.94	30.30	+.15	9.0	−13.8	41	31	18	−19	18	0	29	5	2	83	1.14	+.5	6	8.0	nw.	26	nw.	14	13	10	8	4.9	14.6	4.0
Omaha [1]	982	31	44	29.17	30.30	+.15	8.2	−13.7	40	31	18	−19	18	−1	34	7	3	80	.56	−.1	5	9.8	nw.	36	nw.	11	13	8	10	5.1	10.8	2.9
Valentine	2,598	47	54	27.39	30.28	+.16	10.2	−8.7	41	10	20	−19	18	.0	40	10	7	85	.49	.0	9	8.7	w.	27	nw.	11	8	16	12	5.9	4.9	2.0
Sioux City	1,138	64	106	28.98	30.28	+.13	8.0	−9.8	40	31	17	−20	18	−10	28	7	4	83	.25	−.5	3	10.4	nw.	32	nw.	24	13	8	10	4.6	5.9	.3
Huron [1]	1,289	27	41	28.82	30.30	+.14	4.8	−6.5	40	30	15	−24	18	−6	43	3	1	87	.04	−.5	3	12.4	nw.	42	nw.	11	11	14	6	4.8	2.2	T
Northern Slope							15.0	−4.6										80	0.64	−0.1										6.6		
Billings	3,570	17	31	26.40	30.29	-----	14.3	-----	45	27	24	−21	25	5	38	14	10	78	.68	-----	13	11.2	sw.	36	nw.	10	8	4	19	6.8	12.5	T
Havre	2,507	11	67	27.52	30.33	+.23	7.0	−5.9	47	29	16	−31	25	−2	39	6	3	81	.27	−.5	6	8.8	w.	27	w.	27	5	7	19	7.2	5.6	T
Helena	4,124	85	111	25.88	20.29	+.14	15.4	−4.8	47	27	22	−17	19	8	38	14	9	74	.55	−.3	10	4.9	sw.	25	sw.	14	6	3	22	7.5	9.7	1.7
Missoula	3,263	80	91	-----	-----	-----	21.0	−1.3	41	16	27	−6	21	15	30	18	16	88	1.01	.0	15	5.6	w.	36	e.	17	4	2	25	8.5	11.2	6.5
Kalispell	2,973	48	56	27.05	30.25	+.13	20.4	.0	41	16	27	−7	24	14	28	20	17	84	.58	−1.0	14	4.4	nw.	21	ne.	17	5	2	24	7.8	9.0	2.6
Miles City [2]	2,371	48	55	27.38	30.32	+.20	8.2	−6.3	49	29	19	−30	25	−2	41	6	3	81	.18	−.5	7	5.9	s.	24	nw.	10	5	9	17	7.0	2.4	.8
Rapid City [2]	3,259	50	58	26.75	30.27	+.17	16.2	−5.8	58	29	26	−14	17	6	42	12	9	82	.19	−.3	9	7.4	n.	25	nw.	11	14	7	10	4.9	2.2	T
Cheyenne [1]	6,144	5	39	23.91	30.19	+.14	18.8	−6.7	48	29	29	−19	18	8	43	16	11	72	1.54	+1.1	14	10.6	nw.	40	nw.	16	10	4	17	6.2	18.5	.6
Lander	5,352	60	68	24.66	30.25	+.13	14.2	−4.1	49	16	26	−23	19	2	41	12	8	81	.51	.0	6	3.4	sw.	20	ne.	17	7	14	10	5.6	5.4	1.5
Sheridan	3,790	10	47	26.17	30.28	-----	14.4	-----	53	29	27	−30	25	2	44	12	8	76	.86	.0	10	3.7	s.	26	nw.	10	6	10	15	6.5	12.8	1.6
Yellowstone Park	7,235	12	46	23.88	30.30	+.16	15.8	−1.9	43	28	24	−23	18	7	34	14	10	77	.97	+.2	17	6.6	s.	24	ne.	17	5	4	22	7.3	13.3	9.0
North Platte [2]	2,821	11	51	27.21	30.29	+.17	13.4	−9.5	48	30	23	−18	18	3	32	10	8	89	.31	−.1	4	7.2	nw.	25	nw.	11	18	4	9	4.0	5.6	T

See footnotes at end of table.

TABLE 2.—*Climatological data for Weather Bureau Stations, January 1940*—Continued

District and station	Elevation of instruments: Barometer above sea level	Thermometer above ground	Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Sea level, reduced to mean of 24 hours	Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Departure from normal	Days with 0.01 inch or more	Wind: Average hourly velocity	Prevailing direction	Maximum velocity: Miles per hour	Direction	Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
Middle Slope							**19.3**	**−11.2**										**78**	**0.77**	**+0.2**										**5.5**		
Denver [2]	5,292	106	113	24.70	30.19	+0.04	24.3	−5.5	57	28	34	−7	18	15	44	17	12	69	0.78	+0.4	9	7.8	s.	30	n.	17	9	11	11	6.0	11.2	T
Pueblo [2]	4,670	79	86	25.20	30.22	+.17	21.8	−8.1	61	29	34	−14	19	9	49	16	12	76	.72	+.4	10	5.1	e.	29	nw.	16	8	13	10	5.5	8.9	.0
Concordia	1,392	50	58	28.74	30.30	+.16	12.0	−14.4	43	11	21	−13	18	3	32	11	8	86	.53	−.1	7	7.5	nw.	25	nw.	11	12	6	13	5.3	7.2	1.0
Dodge City	2,509	10	86	27.52	30.27	+.16	16.6	−12.4	46	30	25	−7	18	8	32	15	11	80	.50	+.1	8	11.0	nw.	27	n.	11	11	7	13	5.5	6.7	T
Wichita [2]	1,358	85	93	28.72	30.28	+.15	16.2	−15.1	41	31	24	−7	18	8	27	14	11	83	1.40	+.6	6	8.7	nw.	24	n.	18	10	12	9	5.2	11.8	1.0
Oklahoma City [2]	1,214	10	47	28.82	30.26	+.15	24.9	−11.5	57	28	33	2	19	17	37	21	17	75	.70	−.5	4	9.5	n.	26	n.	18	13	4	14	5.5	6.4	.0
Chadron, Nebr.	3,430	4	58																													
Southern Slope							**36.6**	**−6.2**										**70**	**0.31**	**−0.3**										**5.1**		
Abilene [2]	1,738	10	56	28.33	30.22	+.13	36.4	−7.8	74	13	48	8	19	25	44	29	22	69	.29	−.7	3	9.3	n.	34	w.	13	11	7	13	5.2	2.5	.0
Amarillo [2]	3,676	10	49	26.40	30.19	+.13	29.3	−6.0	66	30	39	1	7	19	46	22	20	85	.52	.0	7	8.1	w.	24	nw.	13	13	8	10	5.1	4.3	.0
Del Rio	960	63	71	29.16	30.17	+.11	44.5	−7.8	77	13	54	19	19	35	36	38	30	61	.33	−.2	3	7.8	se.	37	n.	13	8	10	13	5.8	2.8	.0
Roswell	3,566	75	85	26.43	30.14	+.10	36.2	−3.0	69	31	50	6	19	22	49	30	23	65	.11	−.4	5	7.1	s.	40	nw.	13	16	6	9	4.4	.5	.0
Southern Plateau							**44.3**	**+2.4**										**57**	**0.48**	**−0.1**										**5.0**		
El Paso [2]	3,778	82	101	26.10	30.00	+.08	42.6	−2.4	69	31	54	13	19	32	30	34	25	59	.54	+.1	2	7.6	w.	27	ne.	18	14	12	5	4.2	3.6	.0
Albuquerque [1]	5,314	5	34	24.75	30.08		35.2	+1.1	59	31	46	9	19	24	34	30	24	66	.52	+.1	2	7.9	ne.	41	nw.	13	11	5	15	5.4	T	.0
Santa Fe	7,013	38	53	23.20	30.09	+.05	29.7	+.9	54	30	39	3	19	20	34	25	19	66	.77	+.1	6	6.0	n.	20	n.	27	11	7	13	5.5	7.7	.0
Flagstaff	6,907	10	50																													
Phoenix [2]	1,107	39	51	28.85	30.03	.00	55.6	+4.4	82	29	69	29	14	42	37	44	31	47	.04	−.8	2	4.9	e.	24	w.	5	8	10	13	5.9	.0	.0
Yuma	141	9	54	29.90	30.04	−.01	59.2	+4.8	81	30	71	40	19	48	30	49	37	47	.04	−.4	1	5.6	n.	23	n.	15	15	13	3	4.0	.0	.0
Independence	3,957	5	26	26.01	30.09	+.02	43.6	+5.4	66	26	56	23	13	32	34				.99	+.1	7			26	n.	12						
Middle Plateau							**31.9**	**+3.9**										**80**	**2.27**	**+1.2**										**6.7**		
Reno [2]	4,527	61	76	25.61	30.11	−.02	34.6	+3.0	59	27	43	11	13	26	27	31	28	79	3.72	+2.2	14	4.6	sw.	28	w.	2	7	6	18	6.4	5.8	.0
Tonopah	6,090	12	20																													
Winnemucca	4,344	18	56	25.65	30.12	−.04	33.3	+4.7	58	31	42	7	16	25	31	31	28	81	1.69	+.7	13	7.4	ne.	26	sw.	2	6	10	15	6.7	2.5	.0
Modena	5,473	10	46	24.64	30.08	−.02	31.1	+4.4	53	28	41	5	14	21	31	28	25	78	.61	−.2	10	7.9	sw	29	nw.	12	9	7	15	6.3	3.2	.0
Salt Lake City [1]	4,227	32	46	25.79	30.16	+.01	32.0	+2.8	51	26	38	11	19	26	19	29	27	84	3.90	+2.6	15	5.3	nw.	31	ne.	18	5	4	22	7.7	16.1	.0
Grand Junction	4,602	60	68	25.45	30.12	+.06	28.6	+4.6	49	31	36	3	19	21	26	26	22	76	1.43	+.8	14	4.4	se.	15	nw.	18	7	7	17	6.5	7.7	.0
Northern Plateau							**30.3**	**+2.9**										**83**	**1.76**	**+0.1**										**8.1**		
Baker	3,471	36	54	26.60	30.17	+.01	30.0	+5.1	48	30	37	12	11	23	23	27	25	88	1.79	+.4	16	5.3	se.	17	n.	18	4	9	18	7.3	13.1	T
Boise [2]	2,739	79	87	27.14	30.18	−.01	33.0	+3.2	52	27	40	16	18	26	22	31	28	82	1.84		13	8.6	se.	31	se.	18	5	11	15	7.0	3.5	.0
Pocatello [1]	4,478	5	31	25.53	30.20	.00	24.8		49	1	32	−2	19	18	27	24	22	90	2.52	+1.2	15	8.7	sw.	36	ne.	17	2	3	26	8.6	19.2	T
Spokane [2]	1,929	101	110	28.03	30.17	+.05	30.0	+2.5	51	31	35	13	11	25	19	28	23	75	1.09	−1.1	10	6.8	ne.	23	ne.	23	4	4	23	8.0	6.2	.9
Walla Walla	991	57	65	29.06	30.17	+.02	32.8	+.1	53	3	37	18	25	28	22	31	28	84	2.20	+.2	16	4.1	s.	15	s.	15	3	0	28	9.0	17.8	1.0
Yakima	1,076	58	67	28.99	30.18		31.1	+3.7	48	29	37	15	25	26	24	29	24	78	1.12	−.2	12	4.3	ne.	24	ne.	17	2	6	23	8.5	6.8	1.9
North Pacific Coast Region							**43.9**	**+3.9**										**78**	**3.64**	**−3.0**										**8.1**		
North Head	211	8	56	29.74	29.97	−.08	45.7	+3.6	64	30	50	31	24	41	15	43	39	79	4.32	−4.5	16	17.4	e.	65	s.	26	3	6	22	8.2	.0	.0
Seattle [2]	125	90	321	30.00	30.03	−.02	45.4	+5.9	65	28	51	31	24	40	18	40	35	73	3.10	−1.8	15	8.3	se.	39	s.	26	1	6	24	8.6	.8	.0
Tacoma	194	172	201	29.80	30.01	−.03	43.9	+5.0	62	28	49	30	24	38	18				2.16	−4.0	16	7.1	n.	34	s.	26	1	5	25	8.5	.6	.0
Tatoosh Island	86	9	55	29.85	29.95	−.03	45.9	+4.7	61	28	49	33	24	43	11	43	38	75	8.46	−3.4	18	26.6	e.	61	e.	24	5	3	23	8.1	.3	.0
Medford [1]	1,329	29	58	28.60	30.04		42.0	+4.1	65	28	51	20	15	33	31	40	37	83	1.85	−.9	12		nw.				3	7	21	6.8	.0	.0
Portland, Oreg. [2]	154	68	106	30.00	30.04	−.04	42.2	+2.8	60	30	47	27	24	37	22	38	33	73	2.36	−4.2	13	7.6	e.	24	e.	24	2	6	23	8.4	T	.0
Roseburg	510	45	76	29.46	30.02	−.08	42.4	+1.2	63	1	49	24	16	36	26	41	38	86	3.26	−2.0	16	3.5	nw.	17	sw.	9	3	5	23	8.4	.0	.0
Middle Pacific Coast Region							**50.2**	**+3.2**										**78**	**9.62**	**+4.1**										**7.8**		
Eureka	60	72	88	29.92	29.99	−.11	51.8	+4.9	73	27	58	32	13	45	23	48	44	74	4.37	−2.7	16	7.7	se.	30	sw.	26	5	3	23	7.8	.0	.0
Redding [1]	722	20	34	29.26	30.04		47.5	+2.2	73	29	54	28	18	41	32	44	39	75	16.16	+9.3	15	6.7	nw.	27	se.	8	5	3	23	8.0	.0	.0
Sacramento [2]	66	92	115	30.03	30.06	−.06	48.8	+3.0	66	26	54	31	17	44	22	47	45	85	7.98	+4.3	18	6.9	se.	28	se.	25	5	5	21	7.6	.0	.0
San Francisco	155	112	132	29.86	30.03	−.08	52.6	+2.7	67	29	57	38	18	48	15	50	46	80	9.98	+5.4	18	7.8	n.	27	se.	7	7	4	20		.0	.0
South Pacific Coast Region							**55.7**	**+4.0**										**77**	**3.99**	**+1.7**										**7.3**		
Fresno [1]	327	97	105	29.78	30.09	−.01	48.8	+2.6	70	26	55	29	15	42	25	47	45	87	5.80	+4.2	15	5.2	se.	25	nw.	12	3	5	23	8.2	.0	.0
Los Angeles	338	159	191	29.69	30.06	−.02	59.8	+5.2	85	28	67	47	14	52	30	52	46	66	4.33	+1.2	12	5.3	ne.	22	ne.	23	10	4	17	6.2	.0	.0
San Diego [2]	87	62	70	30.03	30.06	−.01	58.6	+4.3	73	29	65	45	17	52	23	54	51	79	1.75	−.3	10	5.9	nw.	19	se.	8	5	4	22	7.5	.0	.0
West Indies																																
San Juan, P. R.	82	9	54	29.93	30.02		76.0	+1.0	87	27	81	68	15	71	16				3.49	−.7	11	8.7	e.	30	ne.	11	15	13	3	4.3	.0	.0
Panama Canal																																
Balboa Heights	118	6	92		[5]29.86	+.03	79.9	.0	90	9	88	68	27	72	19			[3]75	3.14	+2.1	7	8.1	nw.	24	n.	29	4	23	4	4.9	.0	.0
Cristobal	36	6	97		[5]29.89	+.02	80.9	−.6	87	7	85	73	4	77	12	74	72	[3]77	2.67	−.7	16	13.0	n.	30	n.	28	5	17	9	5.8	.0	.0
Alaska																																
Fairbanks	454	11	87																													
Juneau	80	96	116	[4]29.82	[4]29.91		32.8	+5.4	48	29	37	14	15	29	17	30	24	72	4.01		17	6.7	w.	26	se.	2	1	4	26	9.1	14.0	T
Nome	22	5	57																													
Hawaiian Islands																																
Honolulu	38	86	100	29.82	29.86		71.2	+.3	79	7	77	61	25	66	15	66	63	77	3.25	−.5	16	8.8	sw.	26	sw.	23	12	12	7	4.8	.0	.0
Late report for December 1939																																
Springfield, Minn.	1,025	4	42				29.4		68	6	40	−2	30	19	36	24	18		.13		3	5.2	w.									.3

[1] Data are airport records. [2] Barometric and hygrometric data from airport, other data from city office records. [3] Observations taken bi-hourly. [4] Pressure not reduced to a mean of 24 hours. [5] Barometric data from city office record.

NOTE.—Except as indicated by notes, 1 and 2, data in Table 2 are city office records.

TABLE 3.—*Data furnished by the Canadian Meteorological Service, January 1940*

Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure: Station reduced to mean of 24 hours	Pressure: Sea level reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷2	Temperature: Departure from normal	Temperature: Mean maximum	Temperature: Mean minimum	Temperature: Highest	Temperature: Lowest	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Total snowfall
	Feet	In.	In.	In.	°F.	°F.	°F.	°F.	°F.	°F.	In.	In.	In.
Cape Race, Newfoundland	99	29.47	29.58	−0.28	26.5	+1.5	31.4	21.6	37	3	2.09	−2.55	16.3
North Sydney, Cape Breton Island	8	29.68	29.74	−.20	21.9	+.2	28.1	15.7	36	3	1.50	−3.59	14.9
Halifax, Nova Scotia	88	29.56	29.84	−.14	20.0	−3.0	25.1	15.0	35	7	1.32	−4.22	5.7
Yarmouth, Nova Scotia	65	29.74	29.85	−.15	23.0	−3.8	28.6	17.5	41	6	4.67	−.21	40.0
Charlottetown, Prince Edward Island	38	29.72	29.81	−.15	16.4	−.8	23.2	9.6	35	−6	1.94	−2.20	18.8
Chatham, New Brunswick	28	29.69	29.80	−.18	10.6	−2.1	21.2	.1	33	−21	1.09	−2.34	10.9
Father Point, Quebec	20	29.83	29.85	−.13	13.3	+4.3	19.1	7.5	30	−10	3.28	+.78	32.8
Quebec, Quebec	296	29.57	29.91	−.13	9.8	+.1	15.0	4.7	29	−15	2.70	−1.13	27.0
Senneterre, Quebec [3]	1,038												
St. Hubert Airport, Quebec [2]	102	29.86	29.98	−.07	8.6	−6.2	15.3	1.9	36	−15	1.52	−2.26	15.2
Ottawa, Ontario	236	29.60	29.99	−.07	6.0	−5.4	13.9	−2.0	38	−18	.93	−2.03	9.3
Kingston, Ontario	285	29.70	30.02	−.05	11.0	−7.2	18.1	4.0	41	−17	2.07	−.76	20.7
Toronto, Ontario	379	29.59	30.03	−.05	18.5	−4.2	24.3	12.7	44	−6	1.96	−.76	11.7
Porquis Junction, Ontario	1,009	[1] 28.82	[1] 29.98		1.5		11.8	−8.8	33	−27	1.50		15.0
White River, Ontario	1,244	28.61	30.04	+.02	2.0	+2.1	14.3	−10.4	29	−50	2.10	+.46	21.0
London, Ontario	808	29.12	30.04		15.0	−7.4	22.0	8.1	40	−12	2.80	−1.14	17.3
Southampton, Ontario	656	29.28	30.02	−.02	15.2	−6.1	22.5	7.8	38	−10	5.20	+1.42	48.9
Parry Sound, Ontario	688	29.28	30.02	−.02	9.0	−5.7	18.7	−.6	37	−24	.75	−3.27	4.1
Port Arthur, Ontario	644	29.34	30.07	.00	8.4	+1.8	17.2	−.3	31	−28	.53	−.25	5.3
Winnipeg, Manitoba	760	29.31	30.24	+.07	2.4	+5.0	11.1	−6.4	37	−29	.54	−.33	4.8
Minnedosa, Manitoba	1,690	28.32	30.26	+.14	1.8	+4.2	11.8	−8.3	38	−33	.17	−.64	1.7
Le Pas, Manitoba	860	29.22	30.27	+.12	−2.4	+4.9	8.0	−12.9	39	−39	.85	+.31	5.0
Qu'Appelle, Saskatchewan	2,115	27.86	30.30	+.16	.8	.0	10.0	−8.3	36	−28	.48	−.23	4.8
Regina, Saskatchewan	1,900	[1] 28.16	[1] 30.32		−3.0	−2.3	7.6	−13.6	35	−36	.17	−.34	1.7
Swift Current, Saskatchewan	2,392	27.31	30.32	+.19	3.1	−3.8	11.0	−4.8	48	−25	.33	−.35	3.3
Medicine Hat, Alberta	2,365	27.66	30.32	+.20	2.9	−9.7	12.4	−6.6	46	−35	.06	+.05	6.6
Calgary, Alberta	3,540	26.40	30.31	+.25	10.6	−.7	21.1	.2	57	−25	.24	−.25	2.4
Banff, Alberta	4,521												
Prince Albert, Saskatchewan	1,450	28.65	30.32	+.20	−.9	+3.2	9.0	−10.8	39	−47	.29	−.46	2.9
Battleford, Saskatchewan	1,592	28.42	30.29	+.17	−3.4	+.4	6.2	−13.0	39	−33	.16	−.37	1.6
Edmonton, Alberta	2,150	27.78	30.29		2.7	−3.5	11.2	−5.8	48	−33	.94	+.09	9.4
Kamloops, British Columbia	1,262	28.78	30.18	+.05	28.0	+6.2	33.5	22.5	50	2	.62	−.38	3.7
Victoria, British Columbia	230	29.76	30.01	−.04	42.8	+4.2	46.5	39.1	55	33	2.08	−2.29	T
Barkerville, British Columbia	4,180												
Estevan Point, British Columbia	20	29.92	29.94		44.6	+4.4	49.6	39.6	59	29	12.79	+.37	.0
Prince Rupert, British Columbia	170	29.71	29.90	+.03	41.4	+6.2	46.1	36.7	62	29	5.65	−4.07	.4
St. Georges, Bermuda	158		29.95	−.18	60.0	−2.8	64.6	55.4	70	45	4.70	+0.18	.0

LATE REPORTS FOR 1939

Stations	Altitude	Station reduced	Sea level reduced	Departure	Mean	Departure	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure	Total snowfall
NOVEMBER 1939													
Quebec, Quebec	296	29.76	30.10	+0.10	30.4	+0.7	35.3	25.5	44	14	1.02	−2.41	0.5
DECEMBER 1939													
Quebec, Quebec	296	29.43	29.75	−.26	19.7	+4.1	24.0	15.4	42	−9	2.82	−.57	15.5
Calgary, Alberta	3,540	26.20	29.96	−.09	30.0	+9.5	40.6	19.4	67	−9	.13	−.44	.7
Banff, Alberta	4,521				25.0	+8.3	31.8	18.2	47	−15	.95	−.25	4.6
Prince Rupert, British Columbia	170	29.44	29.63	−.20	42.2	+5.8	47.0	37.5	52	34	11.71	−.01	.0
St. Georges, Bermuda	158		29.98	−.14	64.3	−.4	68.9	59.6	74	51	3.45	−1.60	.0

[1] Pressure not reduced to a mean of 24 hours.
[2] Observations taken at St. Hubert, airport of Montreal.
[3] Station at Doucet, Quebec, closed; Senneterre, substituted.

TABLE 4.—*Severe local storms, January 1940*

[Compiled by Mary O. Souder from reports submitted by Weather Bureau Officials]

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the United States Meteorological Yearbook]

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
New York, western portion	1–2					Snow	Motor traffic delayed.
Oklahoma City, Okla., and vicinity.	5–6					do	Highways blocked; farm families marooned and intercity traffic paralized in many sections. Storm beginning 10 p. m., of the 5th spread throughout Oklahoma.
Georgia, northern portion	7					Ice	Ice formed at most places from Dalton, Rome, Cedartown and Tallapoosa across the State to Elberton, Lincolnton, Augusta, and Louisville. Much damage to wire systems and interruption to traffic. Travel so difficult and hazardous that schools were closed from a few days to a week.
South Carolina, central and southern portions.	7			3		do	Considerable damage to trees and shrubbery; several persons injured.
Atlantic City, N. J., and vicinity. [1]	8	12:15–10:15 a. m.				Snow	Six persons injured; motoring hazardous.
New York, N. Y. [1]	8			3		do	Storm flurries which fell in the city were produced by the tails of 2 storms. Early morning flights from LaGuardia Field delayed by poor flying conditions. Streets and sidewalks slippery and traffic conditions hazardous.

[1] From press reports.

TABLE 4.—*Severe local storms, January 1940*—Continued

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Iowa [1]	13			4		Snow	All highways in the State dangerous; motorists told to drive only when necessary; cars stalled in deep drifts; visibility poor.
Kansas City, Mo.[1]	13					Glaze	Traffic delayed because of slippery roads and streets.
Wisconsin	13-14				$9,000	Snow and wind	This moderately severe storm that swept over all sections of the State, except the northwest, was preceded by some glaze and sleet with damage to wires and poles. More than 10 inches of snow fell in the section from Lafayette County northeastward to Green Bay. High winds caused much drifting.
Monroe County, Ala., central portion.	14	3 a. m.	880	3	5,000	Tornado	Twelve persons injured; property damaged.
Mount Meigs, Ala	14	5 a. m.	100	4	15,000	do	Ten persons injured; property damaged.
Buffalo, N. Y., southwest of	14					Gales and light snow.	Property damaged; motor traffic difficult.
Syracuse, N. Y., south of	14					Sleet and snow	Motor traffic delayed.
Montpelier-Burlington, Vt.[1]	14					Blizzard	This reported to be the worst storm in 13 years. Between 200 to 300 motorists stalled on either side of Bolton Flats on the Montpelier-Burlington road. The road was closed by motor-vehicle inspectors after midnight. Some motorists turned back on either side of the storm center to Burlington and Montpelier or Waterbury, while scores of others abandoned their cars and sought refuge in nearby farmhouses.
Bakersfield, Vt.[1]	15				1,000	do	Mill blown over; roof of barn blown off and carried about 50 feet landing on another barn which was blown down. Motorists marooned, unable to drive because of poor visibility; much wire trouble as trees fell.
Texas, Panhandle section [1]	18					do	Snow with temperature at 4° in Amarillo, Plainview, and Borger.
Watertown, N. Y., and southward.	19-22					Snow	In some places snow piled up in deep drifts. Country roads completely blocked and main roads kept open with difficulty. Isolated sections snowbound for a week or more.
New York, western portion	21					Wind and snow	High winds drifted roads badly, some being completely blocked to automobile traffic.
Louisiana	22					Snow, sleet, and freezing rain.	Seven to 8 inches of snow recorded in the west-central portion with greater amounts eastward, St. Joseph having 11.3 inches. Considerable sleet and freezing rain in all sections, except in the extreme southeast.
Georgia	23					Snow	This storm, severe for this section, left a cover of 4 inches or more southward to La Grange and beyond Griffin, Greensboro, and Washington. From Atlanta and Tallapoosa northward most stations reported 10 inches or more. Schools closed in many places.
South Carolina	23					do	Heaviest snow in 4 years. Traffic considerably hampered by frozen snow on many streets and highways.
Nashville, Chattanooga, and Knoxville, Tenn., and vicinities.	23				100,000	Snow and ice	Heaviest snowfall recorded in 11 years with below freezing temperature turning snow and slush into crusty ice on streets and sidewalks. In Nashville the ground was frozen to a depth of 18 inches. Roads in many sections impassable; traffic hazardous; schools closed. Several persons died from exposure and accidents; others received less serious injury; many young animals perished.
Virginia	23-24			12	500,000	Heavy snow	Cost of removing snow; $300,000; $200,000 damage to pavements; 4 persons frozen to death and 8 persons died because of fires caused by overheated homes.
Washington, D. C., and vicinity.	23-24					Snow	Traffic almost at standstill; schools closed; persons hours late for office; 60 snow plows used to scrape the city's main traffic arteries. Snowfall of 9.5 inches recorded.
Atlantic City, N. J	24					do	Schools closed for the day; civic and charitable affairs scheduled for evening postponed. Busses delayed, motoring difficult; 2 barge watchmen rescued by coast guards. Nine inches of snow recorded.

[1] From press reports.

DESCRIPTION OF CHARTS

By R. J. MARTIN

Beginning this month the description of charts has been moved to a point immediately preceding the charts. A new chart, No. XIII, giving mean tropopause data for the month, appears in the REVIEW beginning with this issue. The descriptions of the Aerological Charts (VIII through XIII) were furnished by B. Francis Dashiell of the Aerological Division.

Chart I. *Temperature departures and wind roses for selected stations.*—Based on data contained in table 2, this chart presents the departures of the monthly mean surface temperatures from the monthly normals. The shaded portions of the chart indicate areas of positive departures and unshaded portions indicate areas of negative departures. Generalized lines connect places having approximately equal departures of like sign. Charts of monthly surface temperature departures in the United States were first published in the MONTHLY WEATHER REVIEW for July 1909, and continued thereafter, but smaller charts appear in W. B. *Bulletin U* for 1873 to June 1909, inclusive. An innovation has been made in this chart, beginning January 1939. The selected wind rose data formerly published as chart VII have been transferred to this chart. The wind roses are based on hourly percentages by months for 28 selected Weather Bureau stations.

Chart II.—*Tracks of centers of* ANTICYCLONES; and

Chart III.—*Tracks of centers of* CYCLONES. The roman numerals show the chronological order of the centers. The figures within the circles show the days of the month, the location indicated being that at 7:30 a. m., 75th meridian time. Within each circle is also an entry of the last three figures of the highest barometric reading (chart II) or the lowest reading (chart III) reported at or near the center at that time, in both cases as reduced to sea level and standard gravity. The intermediate 7:30 p. m. locations are indicated by dots. The inset map on chart II shows the departure of monthly mean pressure from normal and the inset on chart III shows the change in mean pressure from the preceding month.

The use of a new base map for charts II and III began with the January 1930 issue. Charts IV, V, and VI are based on data found in table 2.

Chart IV.—*Percentage of clear sky between sunrise and sunset.*—The average cloudiness at each regular Weather Bureau station is determined by numerous personal observations between sunrise and sunset. The difference between the observed cloudiness and 100 is assumed to represent the percentage of clear sky, and the values thus obtained are the basis of this chart. The chart does not relate to the night hours.

Chart V.—*Total precipitation.*—The scales of shading with appropriate lines show the distribution of the monthly precipitation according to reports from both regular and cooperative observers. The inset on this chart shows the departure of the monthly totals from the corresponding normals, as indicated by the reports from the regular stations.

Chart VI.—*Isobars at sea level and isotherms at surface, prevailing winds.*—The pressures have been reduced to sea level and standard gravity by the method described by Prof. Frank H. Bigelow in the REVIEW for January 1902, **30:** 13–16. The pressures have also been reduced to the mean of the 24 hours by the application of a suitable correction to the mean of 7:30 a. m. and 7:30 p. m. readings at stations taking two observations daily, and to the 7:30 a. m. or the 7:30 p. m. observation at stations taking but a single observation.

The diurnal corrections so applied, except for stations established since 1901, will be found in the Annual Report of the Chief of the Weather Bureau, 1900–1901, volume 2, table 27, pages 140–164.

The sea-level temperatures are now omitted and average surface temperatures substituted. The isotherms cannot be drawn in such detail as might be desired, for data from only the regular Weather Bureau stations are used.

The prevailing wind directions are determined from hourly observations at almost all the stations. A few stations determine their prevailing directions from the daily or twice-daily observations only.

Chart VII.—*Total snowfall.*—This is based on the reports from regular and cooperative observers and shows the depth in inches of the snowfall during the month. In general, the depth is shown by lines connecting places of equal snowfall, but in special cases figures also are given. This chart is published only when the snowfall is sufficiently extensive to justify its preparation. The inset on this chart, when included, shows the depth of snow on the ground at 7:30 p. m. of the Monday nearest the end of the month and is a copy of the snow chart appearing in the Snow and Ice Bulletin for that week. Generally, the publication of the Weekly Snow and Ice Bulletin commences about the middle of December and continues to near the close of March.

Charts VIII, IX, X, and XI show the monthly mean barometric pressures in millibars, mean temperatures in degrees Centigrade, and resultant-wind directions and forces in Beaufort Scale, for 1.5, 3, 5, and 10 kilometers, respectively. However, the mean pressures given on chart VIII are reduced from 1.5 kilometers to an altitude of 5,000 feet (1,524 meters).

The mean pressures and temperatures, based on observations obtained by radiosondes and airplanes, are shown on charts VIII, IX, and X, for 1.5, 3, and 5 kilometers, respectively, while those based on radiosondes only are given on chart XI for 10 kilometers. All Weather Bureau radiosonde observations are made at 1 a. m., 75th meridian time.

Resultant-wind directions and forces for the month, as shown on charts VIII and IX for 1.5 and 3 kilometers, respectively, are based on observations taken at 5 a. m., 75th meridian time, but the winds given on charts X and XI (5 and 10 kilometers, respectively), are based on the 5 p. m., 75th meridian time, observations, which, as a rule, reach much higher altitudes.

Chart XII represents a mean isentropic chart which has been developed in accordance with methods used by the Division of Research and Education of the U. S. Weather Bureau. This has been described in detail in the January 1939 issue of the MONTHLY WEATHER REVIEW. It is based on the mean free-air data from radiosonde, airplane, and pilot-balloon stations.

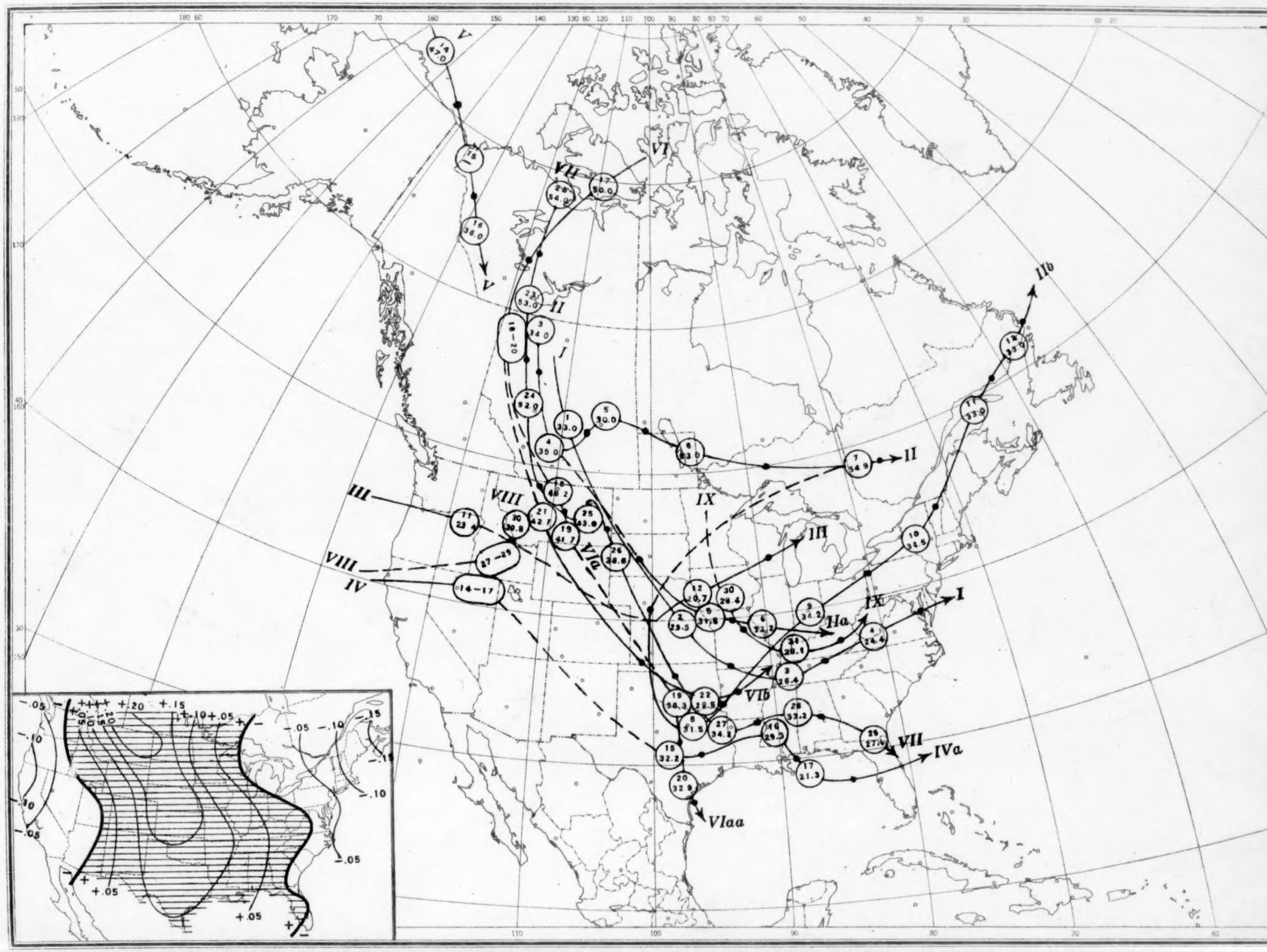
Beginning January 1940 the mean monthly altitudes (in kilometers) of the tropopauses for each radiosonde station, as well as the weighted mean temperatures in degrees Centigrade will be shown on chart XIII. This new chart is prepared from data contained in Aerological table 4, published elsewhere in this REVIEW.

Charts XIV, XV, etc.—*North Atlantic weather maps for particular days.*

U. S. GOVERNMENT PRINTING OFFICE: 1940

Chart I. Departure (°F.) of the Mean Temperature from the Normal, and Wind Roses for Selected Stations, January 1940

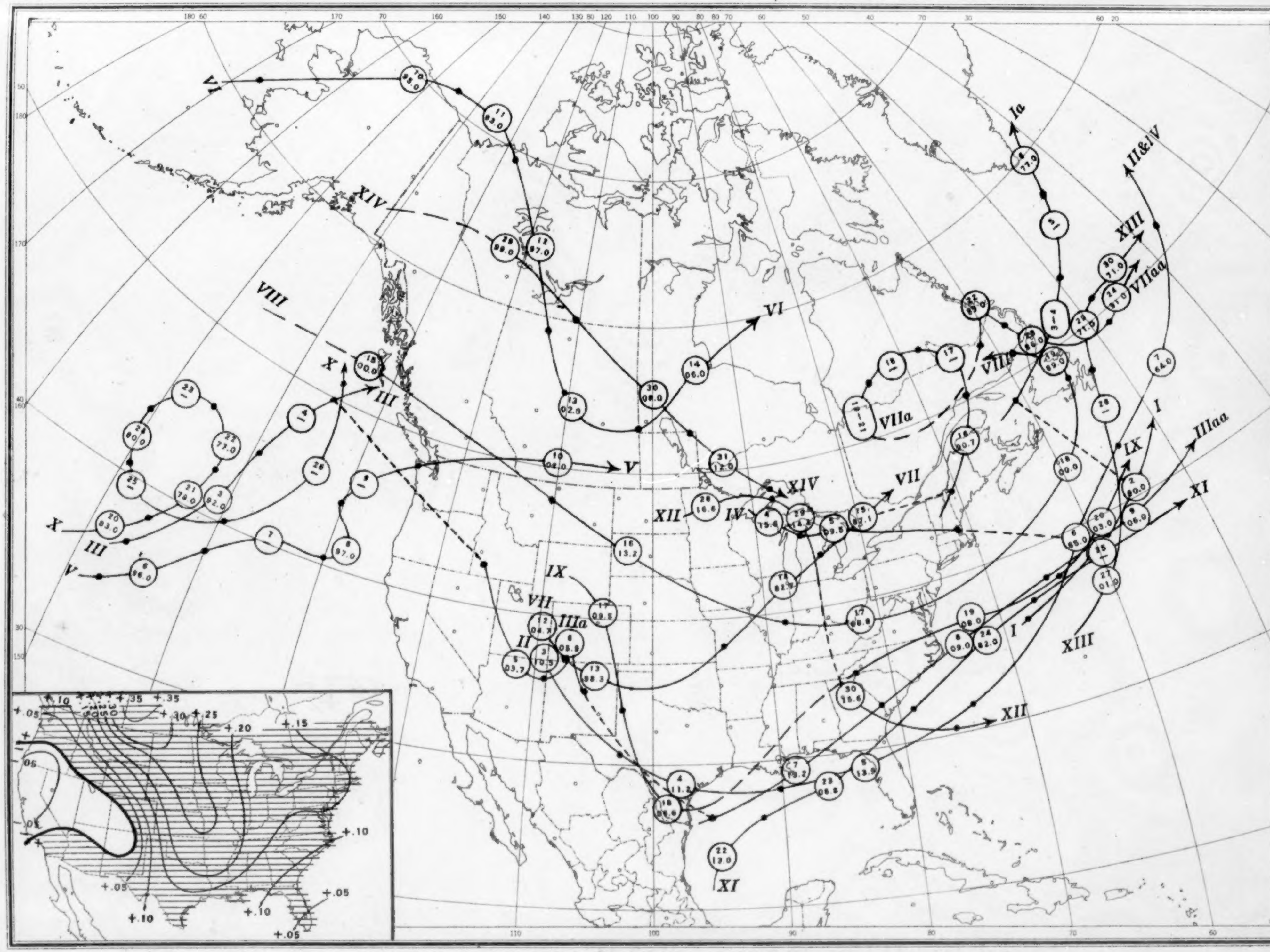
Chart II. Tracks of Centers of Anticyclones, January 1940. (Inset) Departure of Monthly Mean Pressure from Normal



Circle indicates position of anticyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 7:30 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, January 1940. (Inset) Change in Mean Pressure from Preceding Month

Chart III. Tracks of Centers of Cyclones, January 1940. (Inset) Change in Mean Pressure from Preceding Month



Circle indicates position of cyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 7:30 p. m. (75th meridian time).

Circle indicates position of anticyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 7:30 p. m. (75th meridian time).

Chart IV. Percentage of Clear Sky Between Sunrise and Sunset, January 1940

Chart V. Total Precipitation, Inches, January 1940. (Inset) Departure of Precipitation from Normal

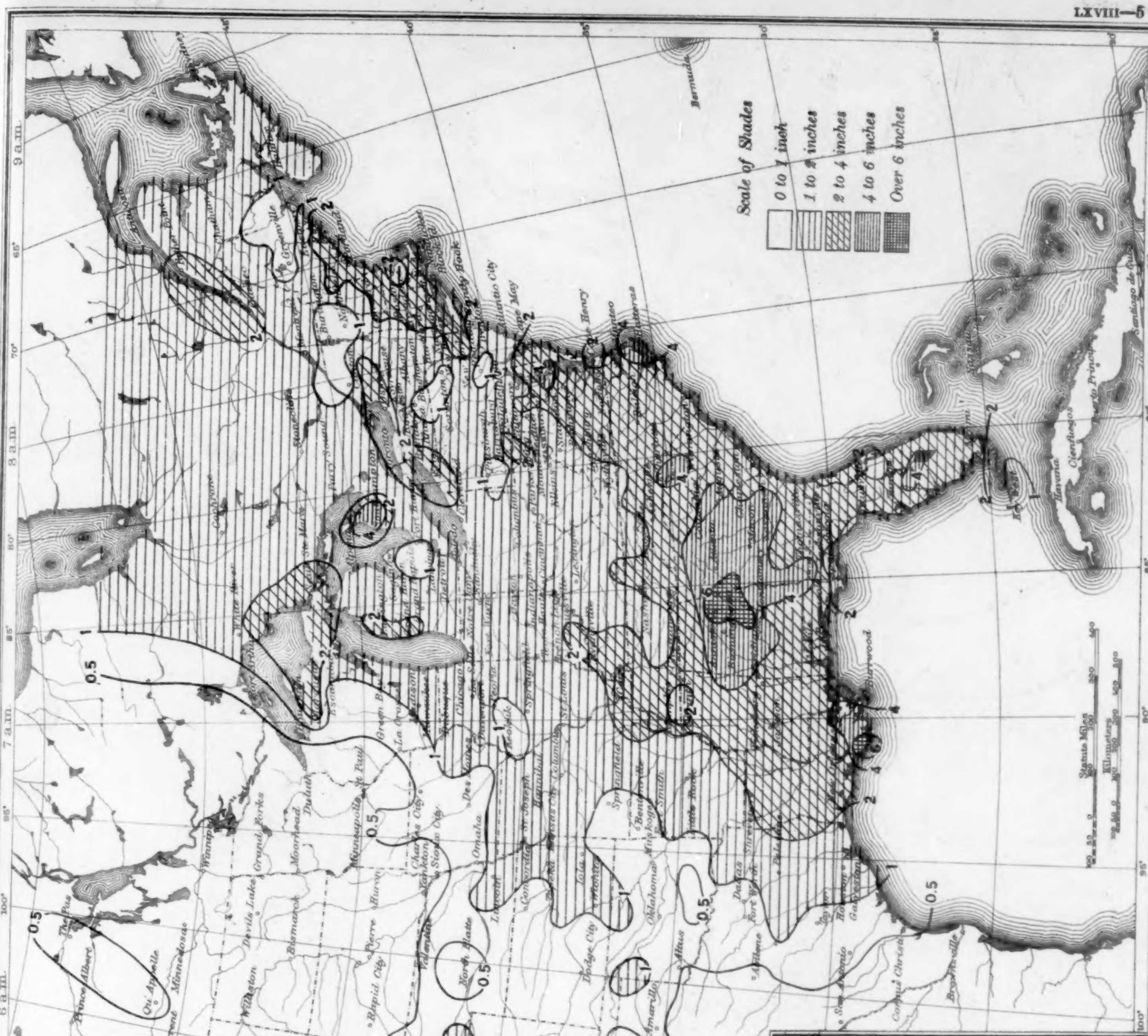


Chart VI. Isobars at Sea Level and Isotherms at Surface; Prevailing Winds, January 1940

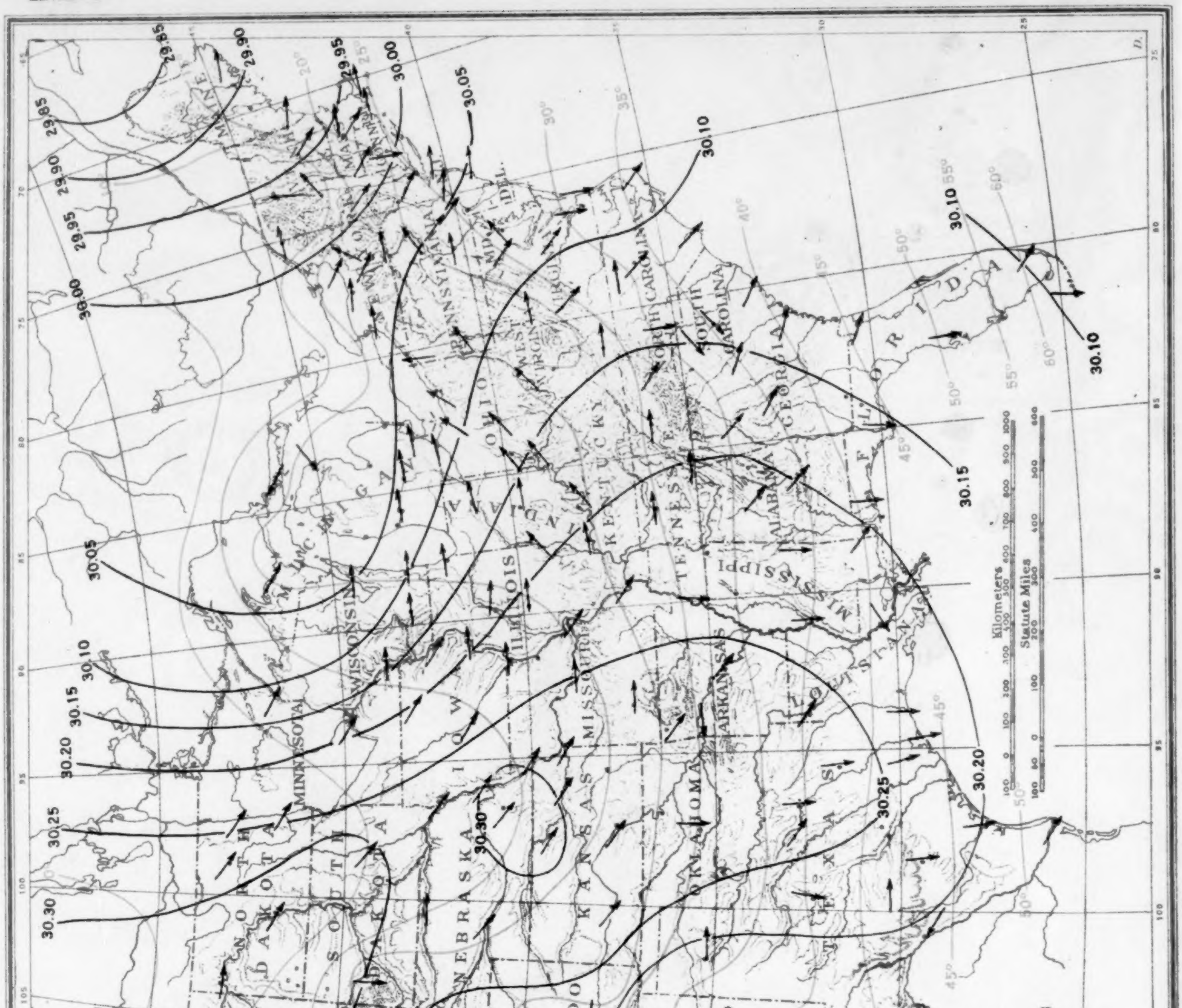


Chart VII. Total Snowfall, Inches, January 1940. (Inset) Depth of Snow on the Ground at 7:30 p.m., Monday, January 29, 1940

Chart VII. Total Snowfall, Inches, January 1940. (Inset) Depth of Snow on the Ground at 7:30 p.m., Monday, January 29, 1940

Chart VIII. Isobars (mb) for 1,524 Meters (5,000 ft.) and Isotherms (°C.) and Resultant Winds for 1,500 Meters

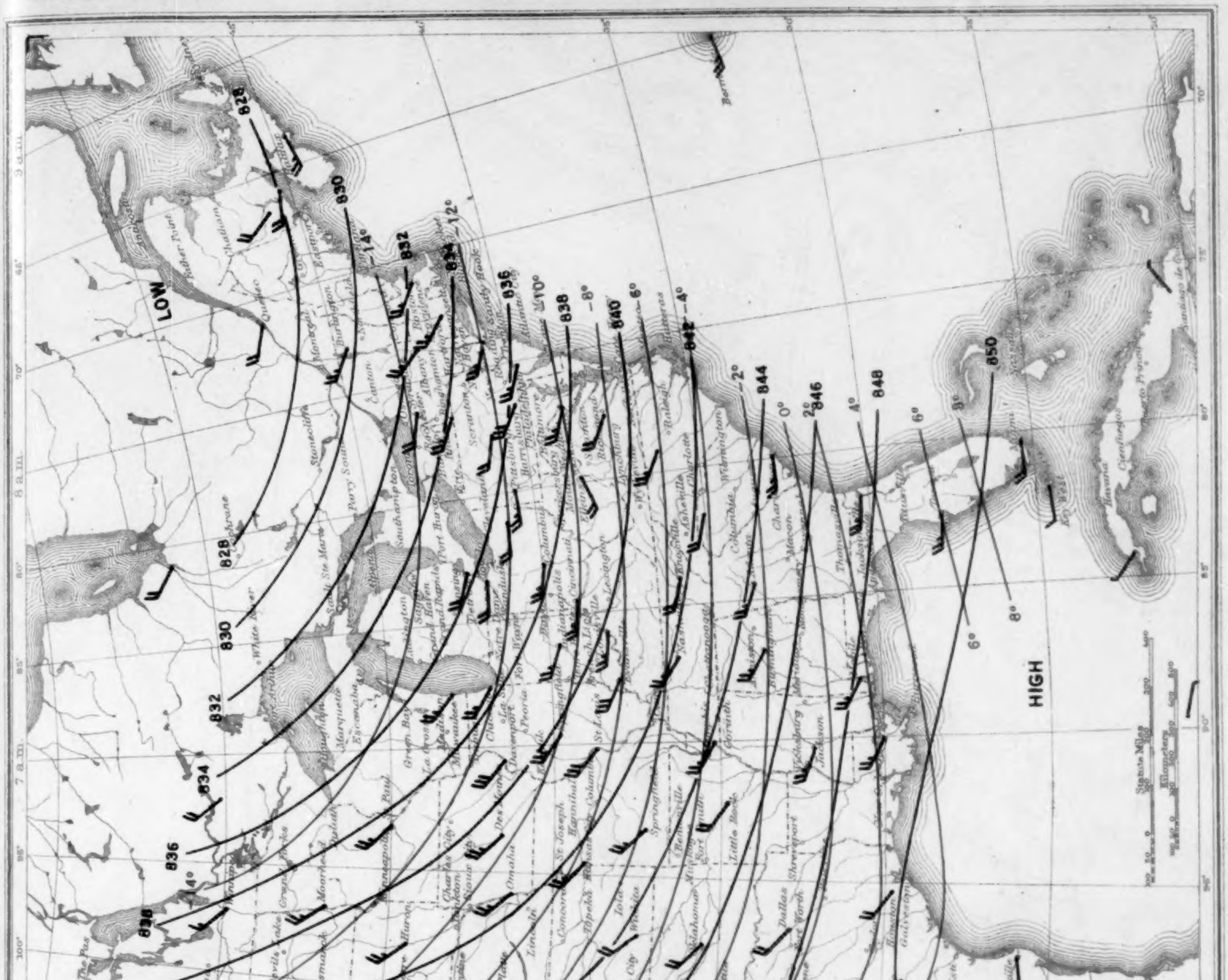


Chart VIII. Isobars (mb) for 1,524 Meters (5,000 ft.) and Isotherms (°C.) and Resultant Winds for 1,500 Meters (m. s. l.) January 1940

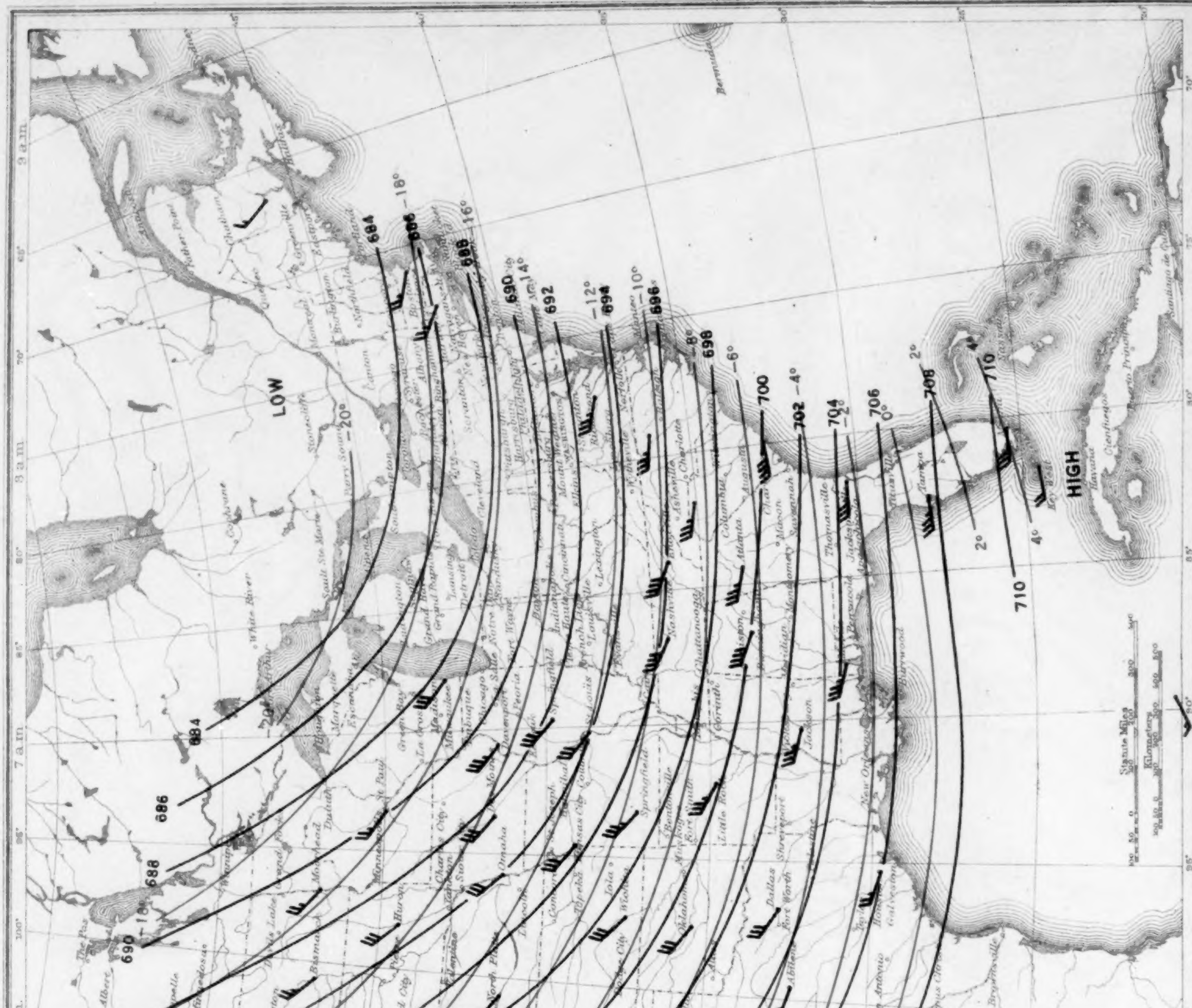


Chart IX. Isobars (mb) Isotherms (°C.) and Resultant Winds for 3,000 Meters (m. s. l.) January 1940

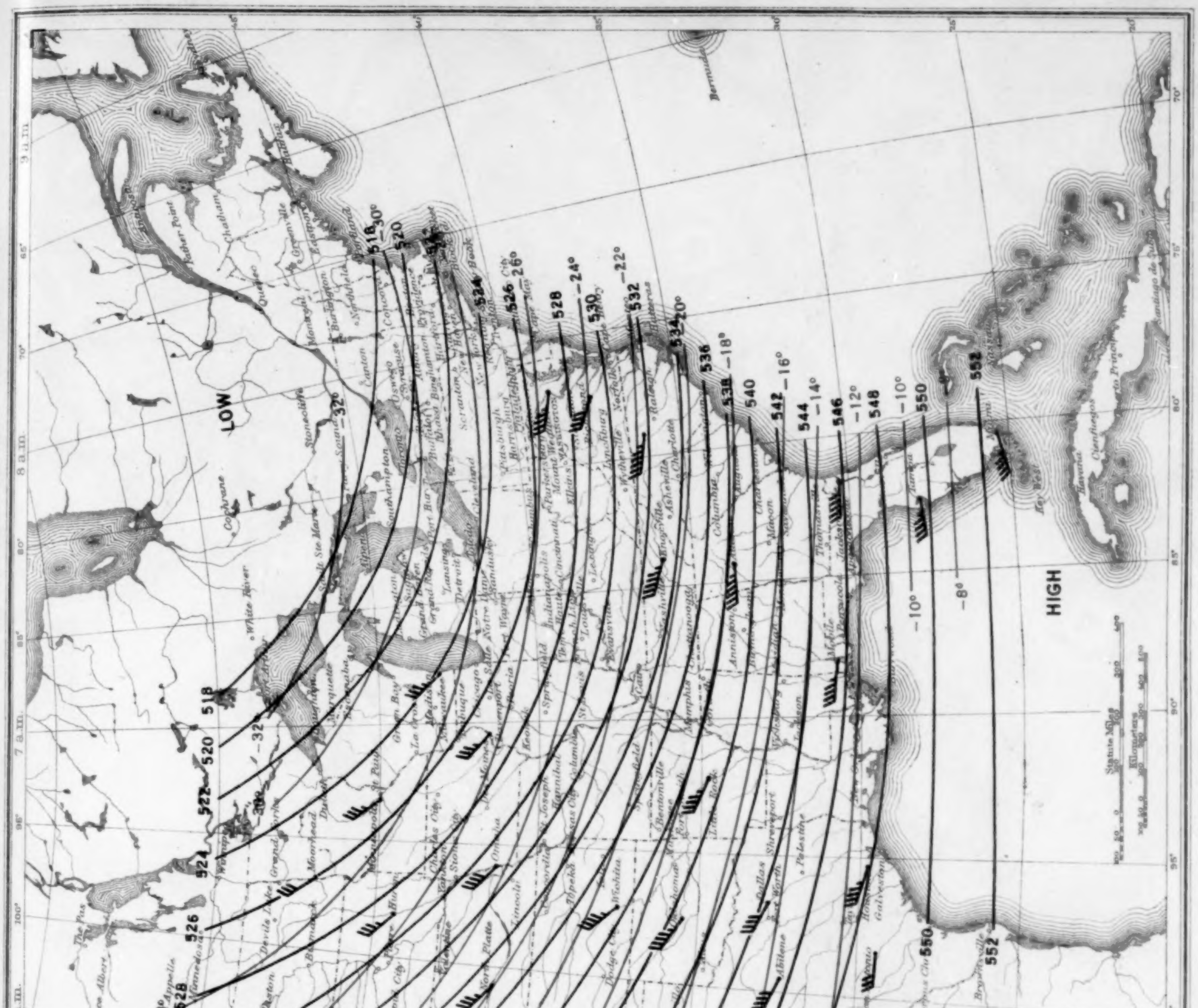


Chart X. Isobars (mb) Isotherms (°C.) and Resultant Winds for 5,000 Meters (m. s. l.) January 1940

Chart XI. Isobars (mb) Isotherms (°C.) and Resultant Winds for 10,000 Meters (m. s. l.) January 1940

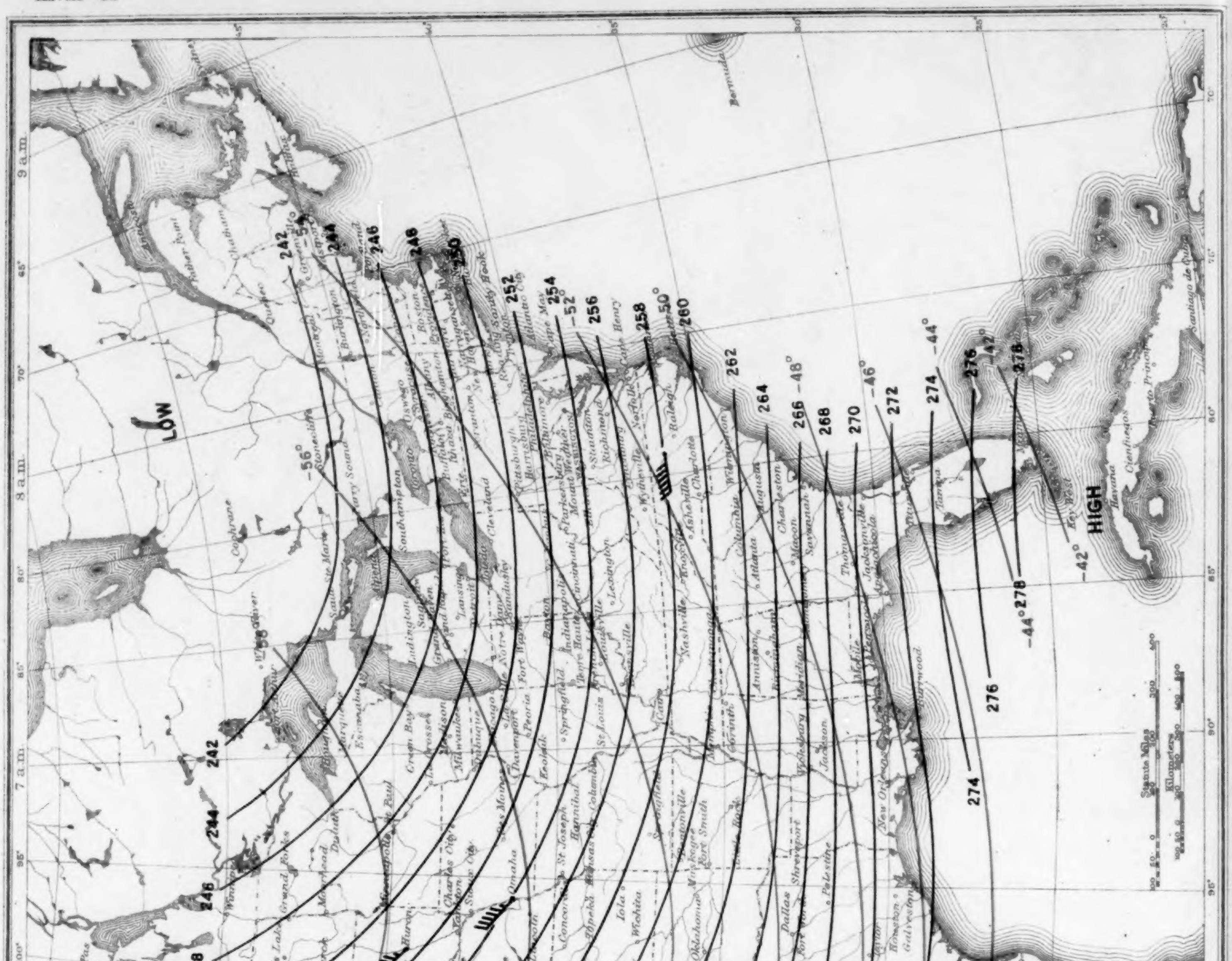


Chart XII. Mean Isentropic Chart, January 1940 (Potential Temperature 296° A.)

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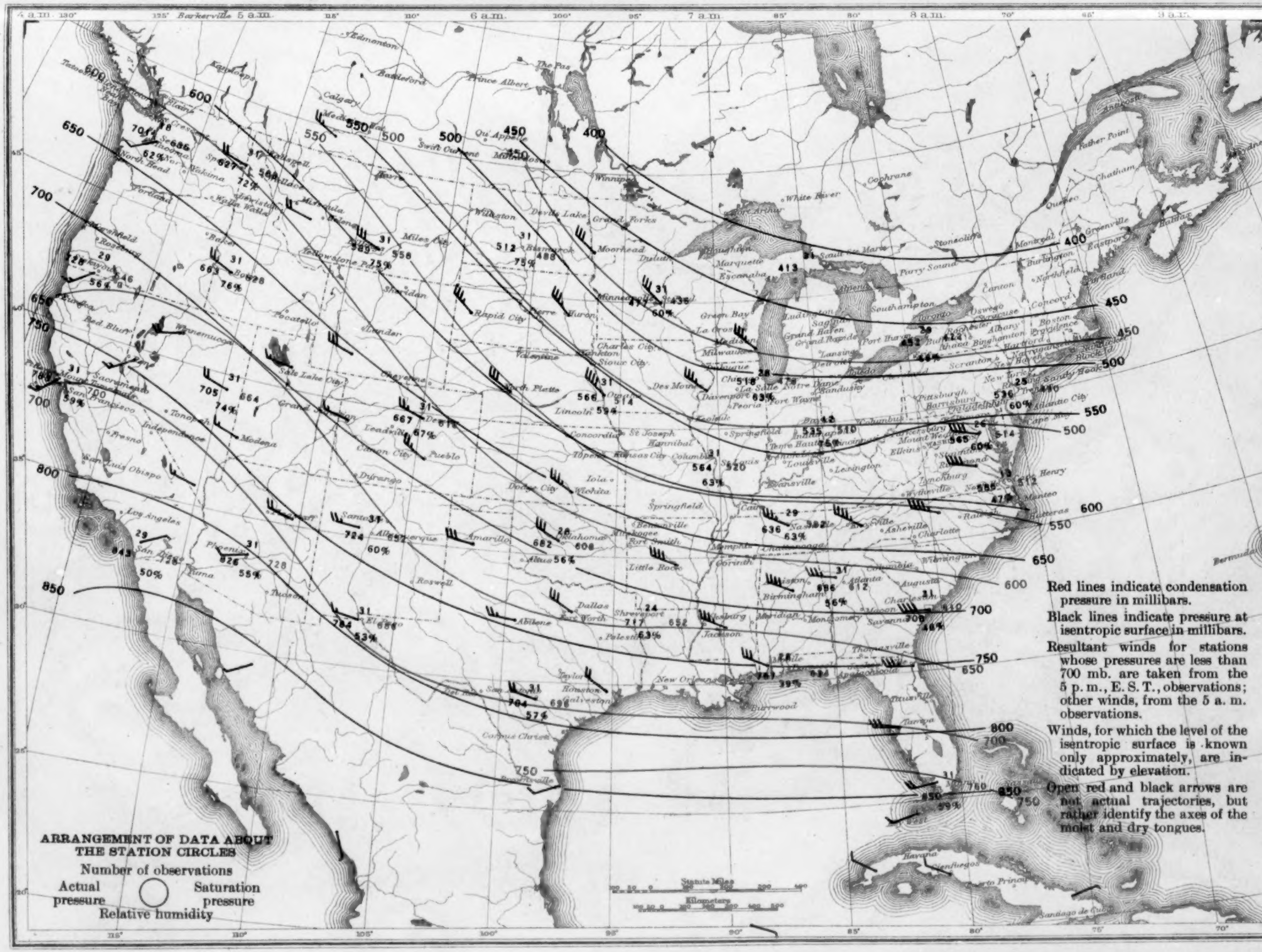

Chart XIII. Mean Tropopause Data, Altitude (km.) (m. s. l.) Temperature (°C.) January 1940

(Data from table 4)

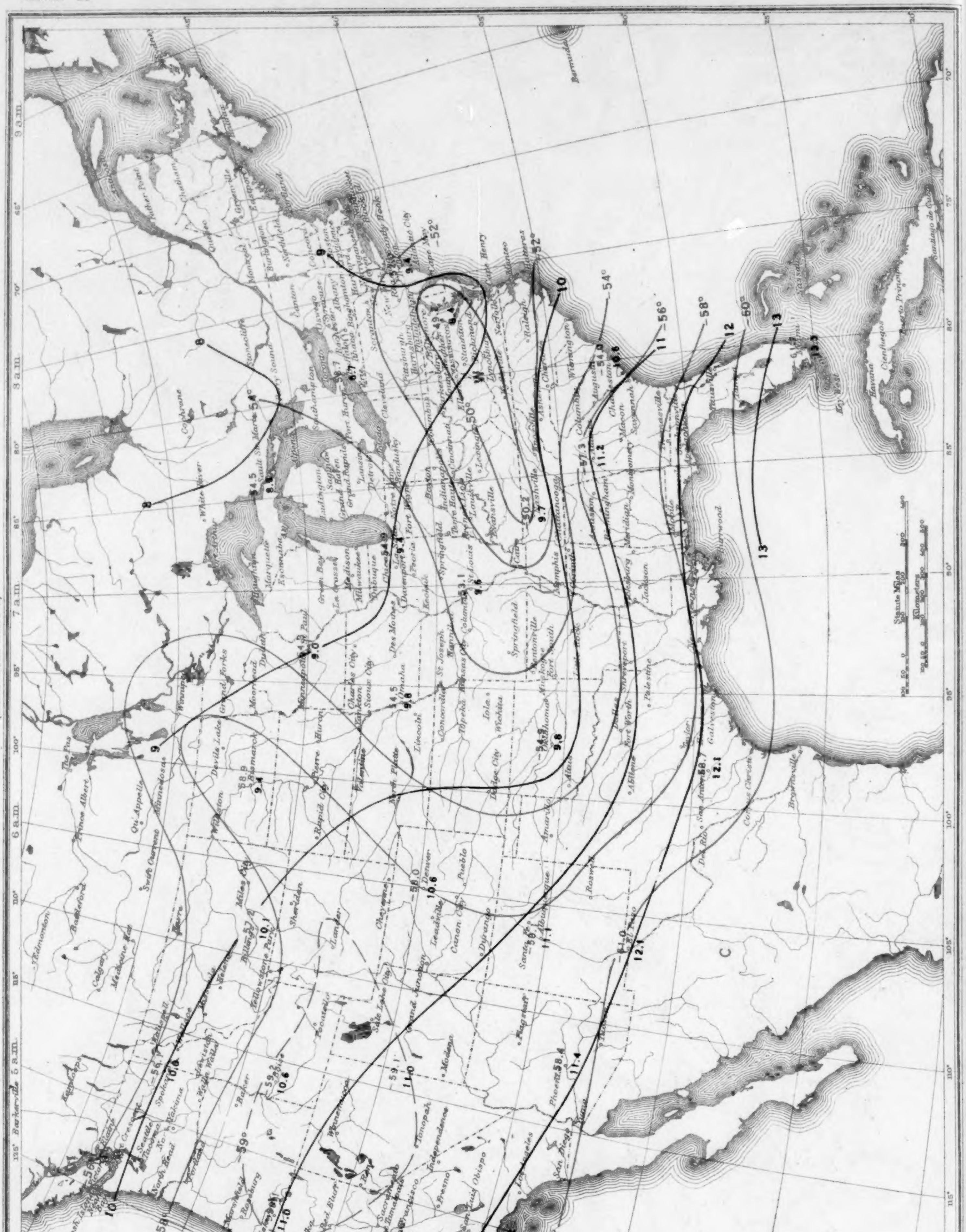

Chart XIV. Weather Map of North Atlantic Ocean, January 24, 1940

Chart XIV. Weather Map of North Atlantic Ocean, January 24, 1940
(Plotted from the Weather Bureau Northern Hemisphere Chart)